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JOURNAL

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(*August* 1943, *Vol. XXII, No.* 8, *Ed. B*)

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THREAD GRINDING
by W. A. Atley

NEW TOOLS FROM SCRAP HIGH SPEED STEEL
by U. F. T. Norris, A.M.I.P.E.

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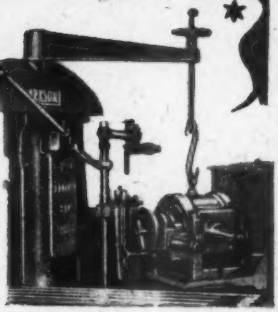

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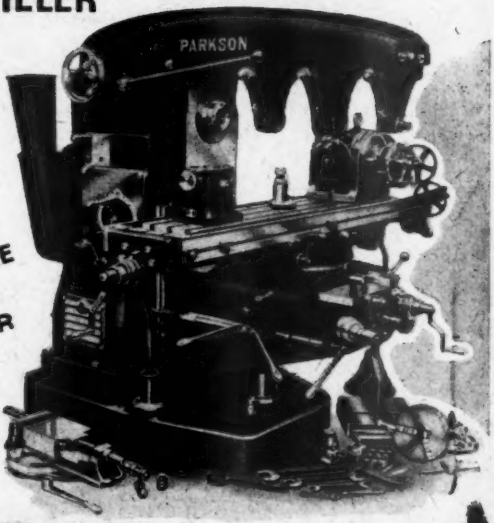

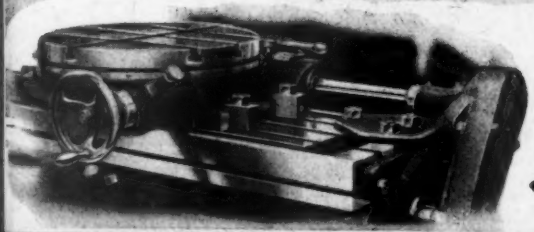

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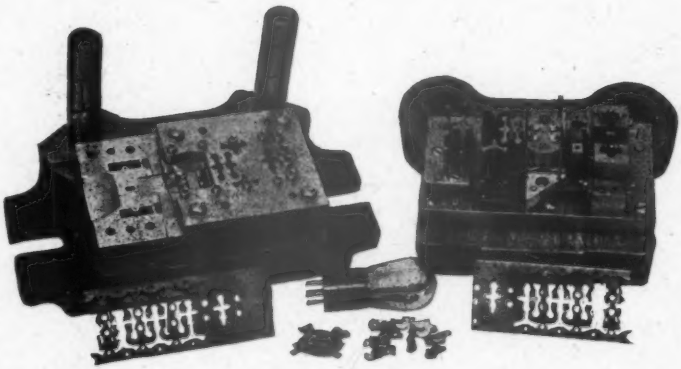

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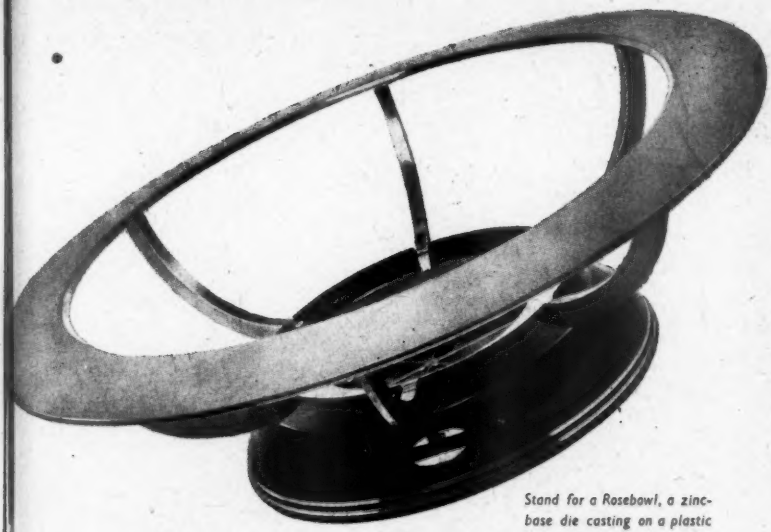

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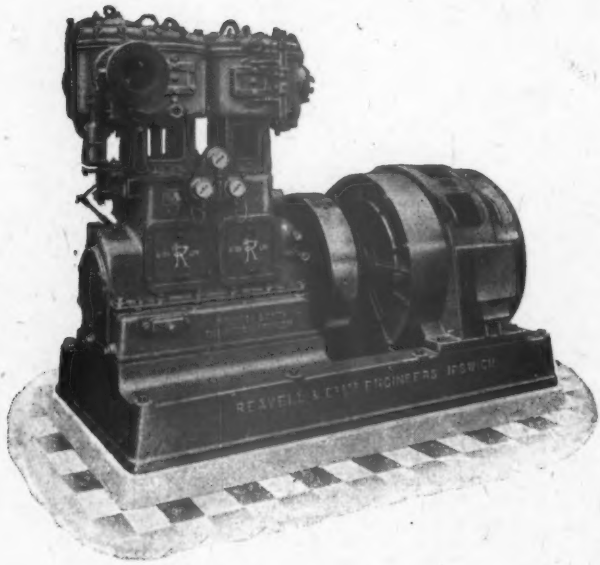

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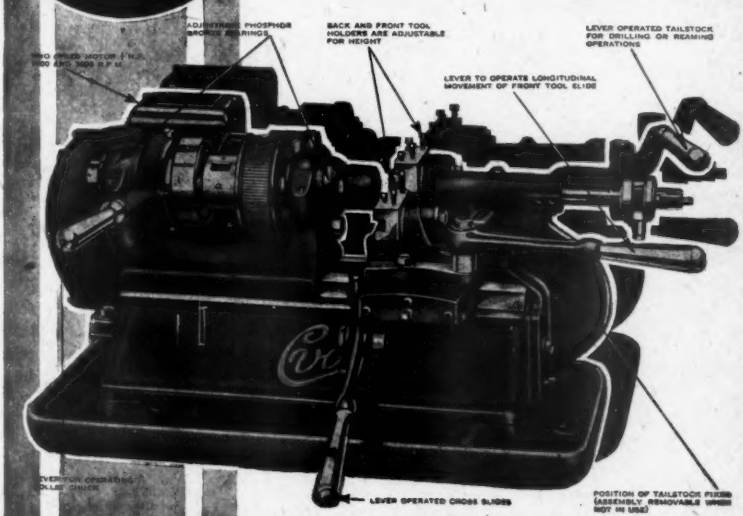
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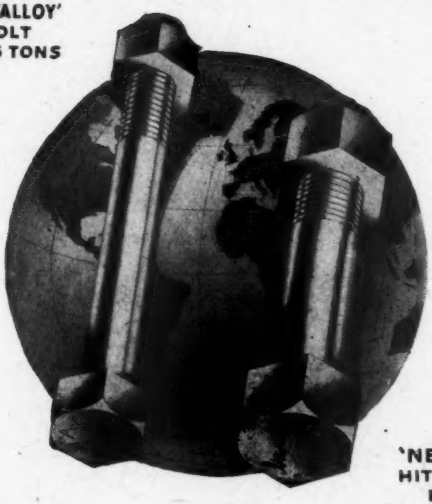

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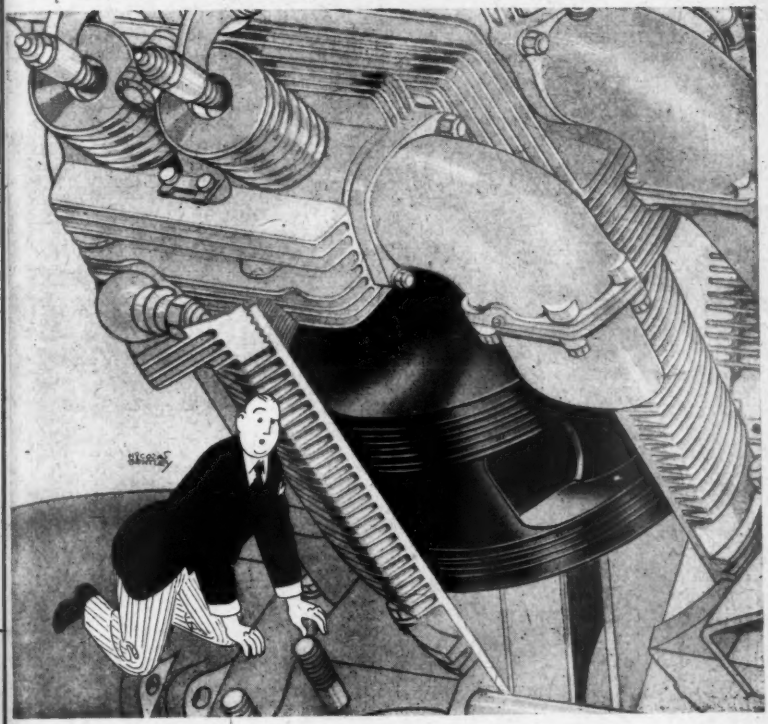

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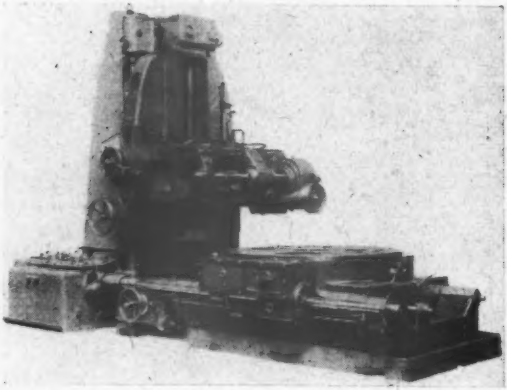

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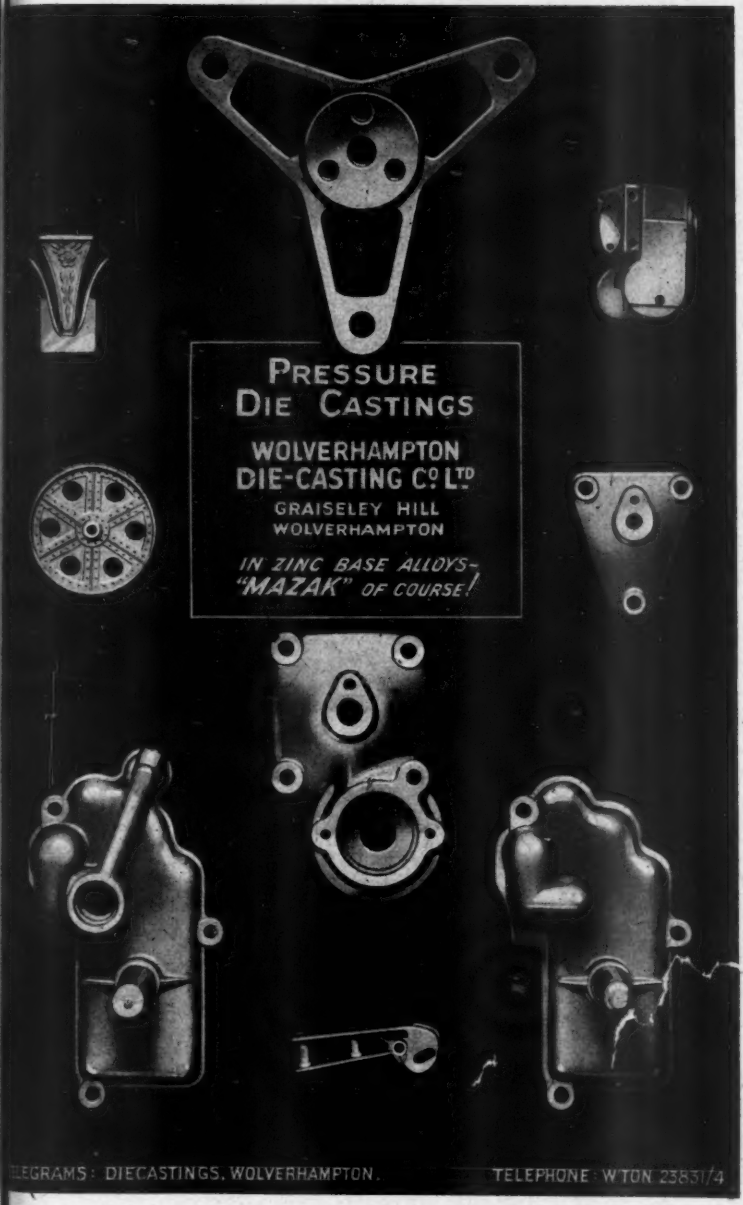
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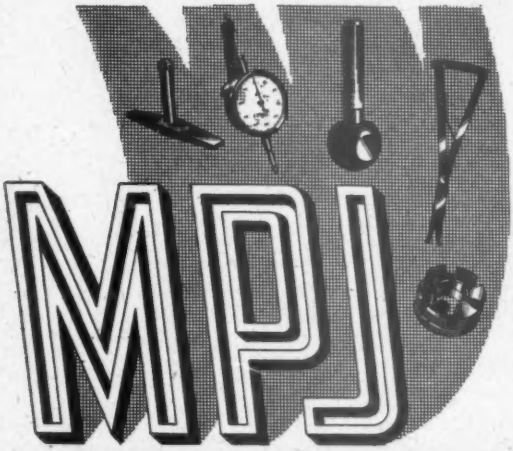

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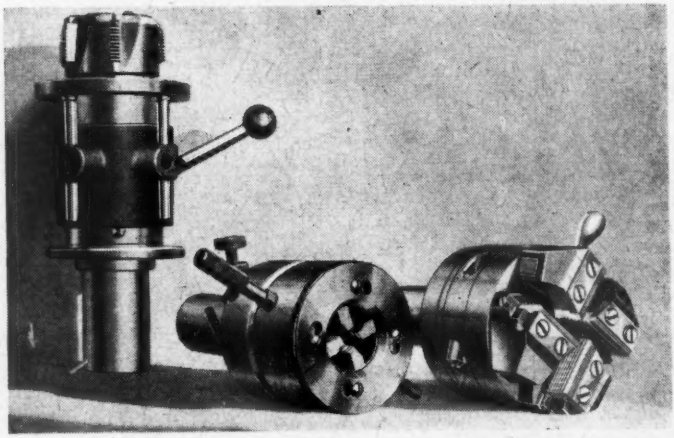

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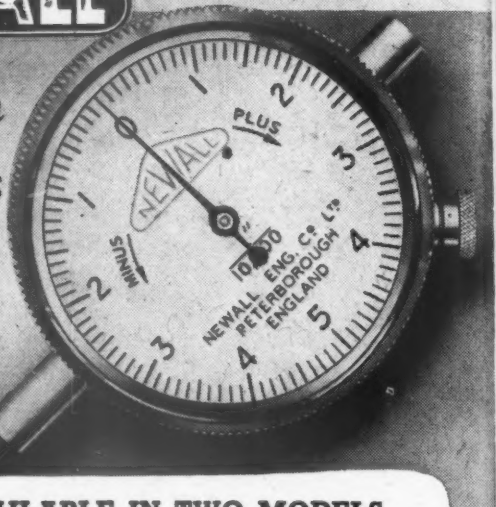

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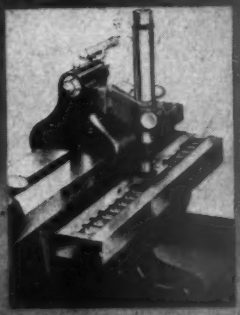

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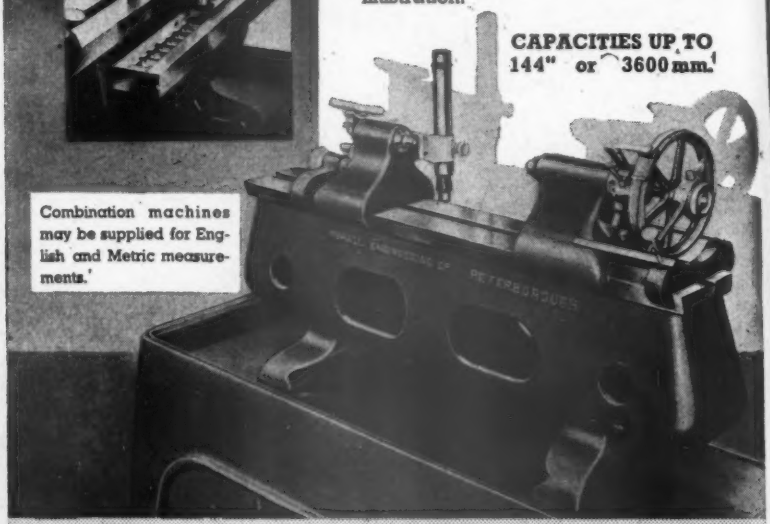

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Snow & Co. Ltd.	xxi B
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Stedall Machine Tool Co. Ltd.	xxxi A
Taylor, Charles, Ltd.	xxvi A
Taylor, Taylor & Hobson, Ltd.	xiv A
Tecnaphot, Ltd.	xxix A
Timbrell & Wright Machine Tool Engineering Co. Ltd.	xxix B
Urquhart, Lindsay & Robertson (Orchar), Ltd.	ii A
Voucher Ltd.	xxvi B
Ward, H. W., & Co. Ltd.	iv B
Ward, Thos. W., Ltd.	iii A
Wickman, A. C., Ltd.	vii A ix B
Wolverhampton Die Casting Co.	xxiii B
Woodhouse & Mitchell Ltd.	xxv A
Wrought Light Alloys Development Association	xxxii A

The fact that goods made of raw materials in short supply owing to war conditions are advertised in "The Journal" should not be taken as an indication that they are necessarily available for export.

The Council of the Institution

AUGUST, 1943

President: Sir Ernest Lemon, O.B.E.

Deputy-President: Lord Sempill, A.F.C.

Chairman of Council: H. A. Hartley.

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Birmingham: F. C. White, "Heath House," Wolston, Nr. Coventry.
Cornwall: J. Arthur, "Clifton," Mount Pleasant Road, Camborne, Cornwall.
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Manchester: F. W. Cranmer, Associated British Machine-Tool Makers, Ltd., Lloyds Bank Buildings, King Street, Manchester.
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Northern Ireland: D. H. Alexander, College of Technology, Belfast.
Nottingham: L. Shenton, "The Anchorage," Shaftesbury Avenue, Sandiacre, Notts.
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Southern: N. J. Cottell (Acting Secretary), Pirelli General Cable Co. Ltd., Eastleigh, Hants.
South Wales and Monmouthshire: J. Vaughan, 131, Penarth Road, Cardiff.
Sydney (New South Wales): J. M. Steer, 260/262, Kent Street, Sydney.
Western: H. D. Glover, 63, Trelawney Road, Bristol, 6.
Yorkshire: D. G. Watkinson, 3, Austhorpe Lane, Whitkirk, Leeds.

INSTITUTION NOTES

August, 1943

Meetings.

September 6—Coventry Graduate Section. A paper will be presented at the Coventry Technical College at 6-45 p.m. on "The Training and Prospects of the Young Engineer" by F. P. Leibert, Grad.I.P.E.

October 11—Coventry Graduate Section. A meeting will be held at the Coventry Technical College at 6-45 p.m. It is proposed to hold an "Any Questions" evening. Five authorities on the following subjects will form a team to answer questions:

1. Production Engineering (Generally). 2. Design. 3. Foundry Work and Foundry Metallurgy. 4. Electrical Engineering. 5. Welfare

Members are invited to send questions to the Hon. Secretary, R. Brittain, Esq., Grad.I.P.E., 135, Croft Road, Nuneaton.

Appointment of General Secretary.

Dr. K. G. Fenelon, Director of the Department of Industrial Administration, Manchester College of Technology, has been appointed general secretary of the Institution in succession to the late Mr. Richard Hazelton.

Annual Election of Past-Vice-Presidents.

The Council have elected Messrs. R. Kirchner, J. T. Kenworthy, J. E. Blackshaw and J. H. Bingham as the four Past-Vice-Presidents for the ensuing year.

Personal.

Mr. H. Grigg and Mr. F. B. White have recently joined the Technical and Publications Committee.

Obituary.

We deeply regret to learn of the death of the following members of the Institution: Mr. Alfred Duxbury, M.I.P.E., and Mr. J. A. Southcott, A.I.P.E.

Formation of new Sub-Section.

Members will be interested to know that a Sub-Section of the Nottingham Section has now been formed. This comprises Lincoln, Newark, Grantham and Gainsborough. Members residing in these areas wishing to attend meetings in Lincoln are requested to forward their names to Mr. R. Preston, Int.A.M.I.P.E., 9, Hunt Lea Avenue, Lincoln.

Subscriptions Received for Research.

During the financial year just ended the following subscriptions have been received for the work of the Research Department:

	£	s.	d.
Norman Davis		10	6
British Thomson-Houston, Ltd.	25	0	0
Stephen L. Harnett	1	1	0
Frederick H. Schofield & Walter H. Low		10	6
Clarkson (Engs.) Ltd.	5	5	0
Boulton Paul Aircraft Ltd.	25	0	0
Edward Pryor & Sons	20	0	0
Howard Wall, Ltd.	10	10	0
A. Goldman	20	0	0
S. & S. Precision Tool Co.	5	5	0
R. S. Lewis	1	0	0
R. J. Fraser		10	0
Ruston Bucyrus, Ltd.	50	0	0
A. E. Judd	2	0	0
Deloro Smelting & Refining Co., Ltd.	50	0	0
Gauge & Tool Makers' Association	52	10	0
Aladdin Industries, Ltd.	25	0	0
T. H. & J. Daniels, Ltd.	25	0	0
British Northrop Loom Co., Ltd.	10	0	0
Hepworth & Grandage, Ltd.	25	0	0
Wallace & Tiernan, Ltd.	5	5	0
Leyland Motors, Ltd.	100	0	0
B.S.A. Tools, Ltd.	25	0	0
Murex, Ltd.	20	0	0
J. E. Baty & Co., Ltd.	26	5	0
Albion Motors, Ltd.	50	0	0
Associated Equipment Co., Ltd.	100	0	0
G. D. Peters & Co., Ltd.	50	0	0
Vauxhall Motors, Ltd.	250	0	0
Dennis Bros., Ltd.	25	0	0
Reavell & Co., Ltd.	26	5	0
Adamant Eng. Co., Ltd.	26	5	0
Humber, Ltd.	50	0	0
Holman Bros., Ltd.	25	0	0
W. Asquith, Ltd.	26	5	0
Hobbies, Ltd.	10	10	0
George Kent, Ltd.	25	0	0
Hoover, Ltd.	100	0	0
Ferranti, Ltd.	52	10	0
Carried forward	£1347	7	0

Subscriptions Received for Research.—*continued.*

	£	s.	d.
Brought forward	1347	7	0
Thomas Ryder & Son	20	0	0
John Lund, Ltd.	26	5	0
Pressed Steel, Ltd.	100	0	0
H. M. Hobson Components, Ltd.	21	0	0
Cooksedge & Co., Ltd.	10	0	0
Standard Telephones & Cables, Ltd.	100	0	0
G. Beaton & Sons, Ltd.	10	10	0
Brush Electrical Eng. Co., Ltd.	25	0	0
Hayward Tyler, Ltd.	21	0	0
Cutanit, Ltd.	50	0	0
Fred Gilbert (Cardiff) Ltd.	5	0	0
George Bray & Co., Ltd.	50	0	0
Vickers-Armstrong, Ltd. (Bath)	250	0	0
E.M.B. Co., Ltd.	10	0	0
Newton Chambers & Co., Ltd.	100	0	0
A. C. Wickman, Ltd.	26	5	0
Jackson Boilers, Ltd.	5	5	0
L. G. Archer		10	6
Climax Rock Drill & Engineering Co., Ltd. ...	50	0	0
W. A. Cook		5	0
E. J. Ring		5	0
	£2,228	12	6

Newly Elected Members.

Subject to confirmation by the Council the following have been elected to the Institution:

As Members: M. A. T. W. Fiennes, A. Hodgson, J. Murphy, R. S. Odd, J. R. Walton.

As Associate Members: R. A. Crook, H. W. Cullis, D. A. G. Dougal, L. F. Farman, J. A. Gordon, A. C. Haynes, J. E. H. Ley, W. J. Longworth, L. B. Oldfield, G. A. J. Perrie, H. W. Rhodes, L. H. Rhodes, H. M. Sawyer, T. H. Shaw, R. W. Simpson, J. Tait, G. W. Tettmar, J. Walley.

As Associates: C. T. Luker, D. V. Mills.

As Intermediate Associate Members: J. E. Abel, A. P. Akers, G. W. Beadle, J. C. Blore, A. E. I. Bond, R. Brown, R. E. Costello, F. H. Eccersley, H. S. Farn, J. E. Fry, K. H. Graves, E. J. Hampson, N. Hargreaves, F. Hewitt, J. C. Holmes, E. Hood, J. T. Jackson, W. H. Kirk, V. Lovett, D. A. Loydall, H. Miller, F. S. Murphy, E. R. Palmer, F. T. Pay, N. H. Philipson, J. P. Purcell, J. W. Simpson, R. D. Strachan, J. G. Williams.

As Graduates: H. J. Bind, J. H. Cotton, B. Adams, I. T. Clowes, N. A. Dudley, J. K. Greenhalgh, B. J. Hawke, J. H. Hudson, A. W. James, A. Latham, G. A. Lester, N. Moore.

As Students: A. G. Albutt, P. C. Allen, B. Farmery, D. I. Gray, E. E. Harris, D. J. Taysom, J. D. Wharton, R. A. Wild.

Transfers.

From Associate Member to Full Member: H. F. Nutt.

From Intermediate Associate Member to Associate Member: B. E. Curran, J. J. Lowe.

From Graduate to Associate Member: H. S. Walker.

From Graduate to Intermediate Associate Member: J. R. England, L. Hutchinson, W. L. Jones, J. Lee.

From Student to Graduate: K. C. Morgan.

Addresses Wanted.

It would be a great help if any member could give information as to the present address of any of the undermentioned members:

London Section: J. L. Barton, A.M.I.P.E., A. A. Best, A.M.I.P.E., F. A. Betts, A.M.I.P.E., G. Buckle, A.M.I.P.E., C. H. Chinery, Int.A.M.I.P.E., L. J. Fry, A.M.I.P.E., F. G. E. Gardiner, A.I.P.E., A. W. Gegan, Int.A.M.I.P.E., A. C. Ledingham, M.I.P.E., E. Simpson, Int.A.M.I.P.E., A. R. Smith, M.I.P.E., J. Crompton, Int.A.M.I.P.E., R. F. Knowlson, Affiliate, Production Tool Alloy, Firm.

London Graduate Section: H. Bloch, Stud.I.P.E., A. G. Smith, Grad.I.P.E.

Birmingham Section: J. W. Foley, A.M.I.P.E., H. J. Graves, M.I.P.E., A. J. P. Warwick, M.I.P.E.

Birmingham Graduate Section: M. Gaunt, Stud.I.P.E., B. W. Gray, Grad.I.P.E., H. D. Jarvis, Grad.I.P.E., Eric Mells, Grad.I.P.E., B. H. Wakeman, Grad.I.P.E., H. J. Elmore, Grad.I.P.E.

South Western Section: J. A. Crofton, Int.A.M.I.P.E.

Luton Section: A. J. Davey, A.M.I.P.E., C. E. Day, A.M.I.P.E., Arthur E. Thorpe, A.M.I.P.E.

Coventry Section: G. E. R. Davison, A.M.I.P.E.

Preston Section: J. H. Devonald, Int.A.M.I.P.E.

Glasgow Section: W. G. Gibson, M.I.P.E., J. A. Hill, M.I.P.E., A. D. MacIntyre, A.M.I.P.E.

Leicester Section: B. K. Nehru, Stud.I.P.E.

Manchester Section: F. J. Taylor, Int.A.M.I.P.E., Stanley Taylor, Int.A.M.I.P.E., W. Turner, A.M.I.P.E., Richard Wake, A.M.I.P.E.

Nottingham Section: Alex. L. Terry, Stud.I.P.E., A. J. Voce, M.I.P.E.

Western Section: E. W. White, A.M.I.P.E., C. J. Luby, A.M.I.P.E.

THREAD GRINDING

Paper presented to the Institution by

W. A. Atley

THE introduction of thread-grinding as a production method of manufacture has made very rapid strides during the last few years. Earlier it was confined mainly to the production of thread gauges, while for the production of accurately ground components it was, generally speaking, considered a much too expensive method.

That its value as a machining operation has increased so rapidly is due, in a large measure, to the overcoming of the earlier difficulties met with in the manufacture and dressing of a grinding wheel so that an accurate thread form could be maintained.

To-day thread-grinding is recognised as a means by which, in many cases, production can be increased. The number of components scrapped as the result of subsequent heat treatment is eliminated, while at the same time, the quality of the product is improved. The advantage of thread-grinding on small tools, such as taps, hobs, etc., needs no emphasis. Thread-grinding, moreover, offers many advantages as opposed to the more generally known methods of producing screw-threads, i.e., die-heads, thread-milling, rolling, or the use of a single-point tool. It is intended, in this article to show some of these advantages, and to indicate how some of the difficulties met may be dealt with.

When considering the pitch of a hardened component, the old alibi of "it shifted during the hardening" no longer applies, accuracy of the pitch can be guaranteed, and the form of the wheel having been approved, large numbers of components can be ground without further attention. Thread-grinding too, will be found to be the solution to many of the threading problems which arise when the use of modern alloy steels is specified.

This being so, it follows that the employment of this method can have a direct effect on the design and lay-out of manufacture of a component, in that, to obtain the best results certain fundamental points must be observed. For instance, when designing shouldered work, it is essential to provide an adequate undercut before the shoulder. This should be of a depth sufficient to clear the thread, and its length should be at least $1\frac{1}{2}$ times the pitch of the thread to be ground. (Fig. 1). This will ensure that the last thread is a "full" one and not subject to wheel wear. The designer must provide for suitable male or female centres, from which the thread will be ground. Where diameters permit the latter type are preferable, since the

working surface is protected. This is very important as inequalities or damage on centres will be reproduced on the thread. The designer too, can assist in prolonging the life of a grinding wheel, by reducing the diameter of a component beyond the threaded length to be ground. (Fig. 2). This threaded length can then be passed across the whole of the wheel face and it will thus be unnecessary to withdraw

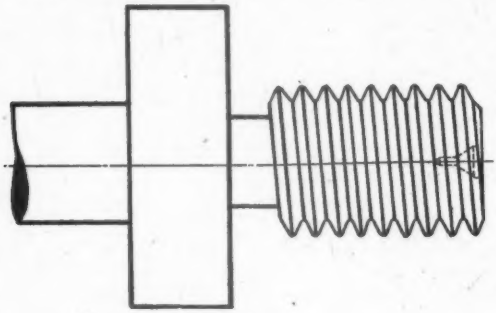


Fig. 1

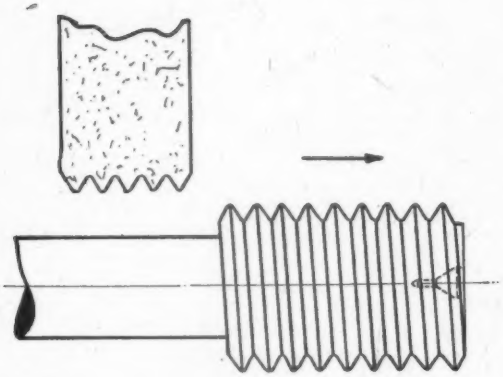


Fig. 2

the wheel, while still in contact with the job, often the cause of "flats" on the thread.

Then again, closer tolerances may be specified if thread-grinding is to be employed. The planning engineer, too, must consider how the lay-out of manufacture is affected. If the part is to be hardened and tempered, then this will need to precede the threading operation.

When planning, for instance, the sequence of operations for a ground-thread tap, the position on the lay-out of the fluting operation is important. If the thread is to be relief ground, then fluting must obviously take place before thread-grinding, but if no relief is specified, then the fluting is best left until after grinding, as it will be found much easier, particularly with an odd number of flutes, to measure the thread and thus control the setting of the machine during the actual grinding operation. It is realised, of course, that this may lead to a reduction in the life of the wheel form, but it is felt that

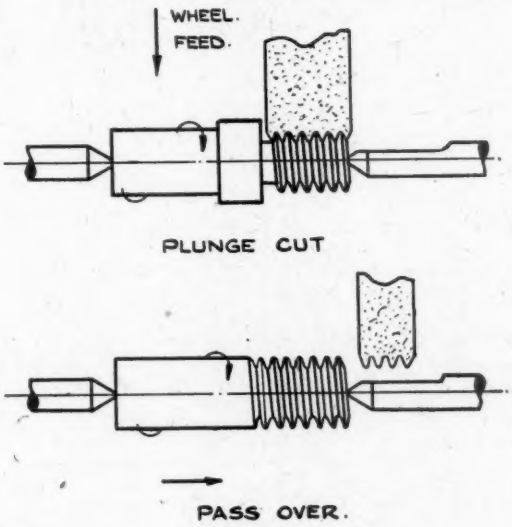


Fig. 3.

the advantage of being able to accurately measure the elements of the thread is well worth while. It will also be for the planning engineer to decide upon which type of machine the component can be produced most economically, and by which method. The type of machine will be dictated largely, by the tolerances specified on the part drawing, for instance, if gauges are to be ground within N.P.L. tolerances, then a precision type of machine is indicated, whereas if the normal B.S.I. limits for ground threads will satisfy the specification, then a production type of machine is the answer. There are two recognised methods of thread-grinding namely, plunge-cut (Fig. 3) and the traverse or pass-over method. With the plunge-cut method, the wheel which must be wider than the length of thread to be ground, is fed straight

into the work to the required depth of thread, while the work is rotating at a slow speed. This is the faster method because only approximately 1½ revolutions of the work is necessary. It has the advantage, too, that wheel wear is uniform across its face, thus it is very suitable for grinding shoulder work. The traverse or pass-over method, as its name implies consists in passing the componenr completely across the wheel-face. In this case, although the wheel wear is not uniform a much longer life is obtained; the major part of the work is done by the leading " rib " on the wheel, whilst the balance of the ribs clean up the thread. Thus, if excessive wear takes place on this first rib, resulting in a shallow thread, by the time the workpiece has travelled across the whole wheel-face, the other ribs will have corrected this—a sort of roughing and finishing operation combined.

There are several good designs of thread-grinding machines on the market, but for the purpose of this article it is proposed to deal only with two of them, namely—The Matrix Universal, a precision machine, and the Wickman-Horstman, a production type machine.

The two methods of grinding, already referred to, are provided for on both of these machines, and in general their design is similar, in that on both, the pitch of the thread to be ground is controlled from a master lead screw and set of change gears. In the case of the production machine referred to, backlash between lead-screw and nut is guarded against by the provision of an hydraulic cylinder which exerts pressure on the nut forcing it against the flanks of the thread on the lead screw. On the precision machine, any pitch errors are taken care of by a pitch correcting device, while on both machines, adjustment for longititudinal movement is provided for, so that it becomes an easy matter to " pick-up " a thread. Each machine, too, can be adjusted to the required helix angle of the thread to be ground, and relief grinding is also provided for.

It is, however, in the dressing of the thread form on the wheel that these machines differ, although on both, the thread-form can be " crushed " into the wheel.

On the Matrix machine the process of " crushing the wheel " is carried out in two operations, the first being to dress the wheel face parallel with the centres on the machine, by means of a diamond dresser mounted on the tailstock and passed across the wheel-face. For the second operation, an attachment mounted above the wheel and carrying an annular grooved crushing roller, (Fig. 4) is used. This is fed down to a pre-set stop, coming to rest a few thousandths clear of the wheel face. The wheel speed is reduced to approximately 200 r.p.m. and with the aid of the handwheel provided, the crushing roller is slowly and evenly forced into the wheel until a depth of penetration approximately .002 in. beyond the depth of thread required is reached; the wheelhead stop button is then immediately

pushed, as the crushing roller must not be allowed to idle with the wheel running, or serious malformation of the thread form results. A graduated ring is then set to the depth that has been reached and the crushing roller wound up, well clear of the wheel, thus, when

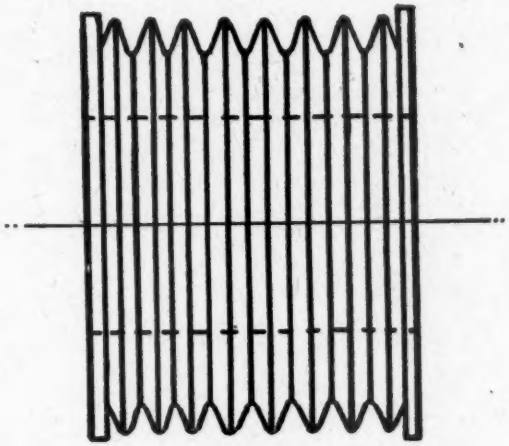


Fig. 4

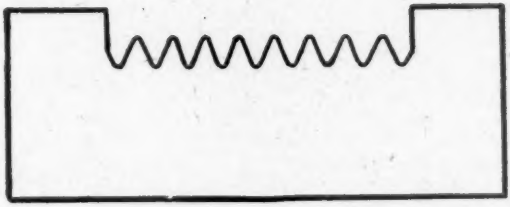


Fig. 5.—Flat test piece for inspection on projector

re-crushing becomes necessary, all that needs to be done is to bring the crushing roller down to the previous setting and to feed-in a further .002 in.—.003 in. A test piece (Fig. 5) is now taken of the wheel thus formed, and providing it is approved, the wheel is ready to grind the workpieces, it only being necessary to set the wheel-head over to the helix angle of the thread to be ground.

On the Wickman-Horstman machine, however, crushing the wheel is carried out in a somewhat different manner. In the first place the

roller used, unlike that previously described, is of helical form (Fig. 6) in other words, it is a screw thread ground on the surface of a hardened steel cylinder. It should be mentioned here, that the crushing rollers on both machines are normally of hardened steel (Rockwell 60.C) ; but should no hardened roller be available for the production machine mentioned, a soft roller may be screw cut on a lathe having a lead screw of accurate pitch. This soft crusher is then used once only, and with the wheel form thus produced,

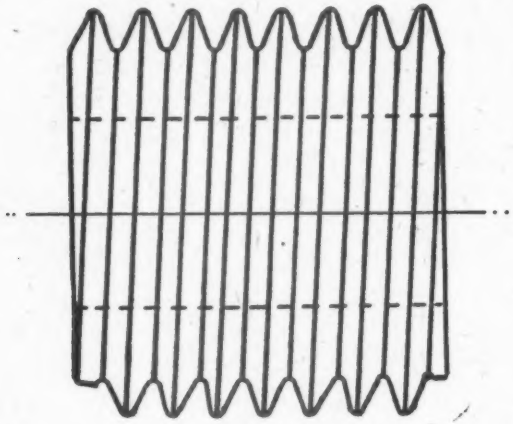


Fig. 6

a hardened blank may be ground. It is important, however, when using a soft crusher made on some other machine, to form only the minimum number of "ribs" on the grinding wheel, otherwise pitch errors will be introduced, resulting in oversize effective diameter threads being produced, due to interference, a sort of side-cutting taking place while thread-grinding.

To return to the Wickman-Horstman machine, the crushing roller being of helical form cannot be fed straight into the wheel, a preliminary grooving being necessary, and before proceeding with the wheel dressing operations on this machine, the wheelhead must be set to the helix angle of the crushing roller to be used. Then having dressed the wheelface parallel with the centre of the machine, and assembled the required change gears, a cranked handle is fitted on to the end of the lead screw. A diamond whose angle and radius is less than that of the thread to be formed (Fig. 7), is selected and fitted in a holder which in turn is mounted between centres on the machine. The lead screw is then rotated by hand, until the diamond

is opposite the leading edge of the grinding wheel (Fig. 8). The wheel-head is then fed forward until a piece of paper of known thickness is just gripped between diamond and wheel, without indenting. The pointer on the in-feed handwheel is now set, (making allowance for

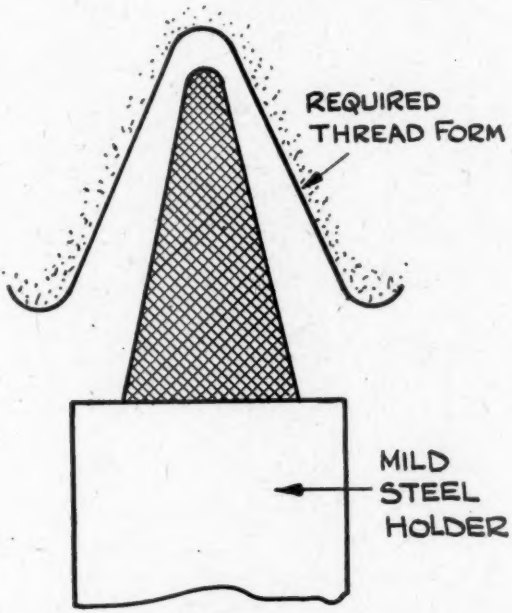


Fig. 7

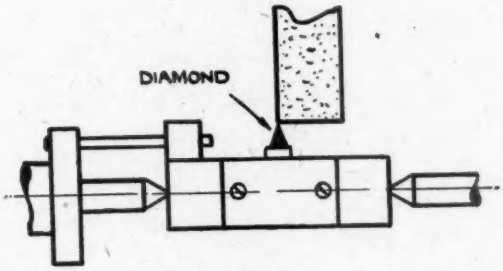


Fig. 8

the thickness of the paper used) to the depth of the thread, less approximately .002 in. to ensure that in the subsequent operation the form will be fully crushed. An in-feed of .0005 in. is now set, and with the wheel running at a speed of approximately 5,000 ft. per min., the diamond holder is traversed, until the complete wheelface has

Fig. 9.

been covered, at each revolution of the diamond holder the wheel is thus "nicked." The wheelhead is then set back to the "off" position and the diamond returned to the starting position. The foregoing operation is now repeated in .0005 — .001 steps, until the depth set by the pointer has been reached. The wheel then has a series of annular grooves around its periphery at the required pitch. Any feather edges should now be dressed-off, as these might break-off and clog the thread on the crushing roller, with disastrous results to the form on the wheel. The next operation is to switch off the wheelhead motor, and to fit a handle to the wheelspindle. The crushing roller is then assembled on to a shaft which is mounted in place of the diamond holder, and the wheelhead fed forward until

the previously formed grooves on the wheel are in engagement with the thread on the crushing roller (Fig. 9). The wheelspindle is now rotated backwards and forwards by hand, at an even speed of approximately 200 r.p.m. always keeping the wheel-face covered by the crushing roller. When the pressure is felt to be eased, a further .0005 in.—.001 in. advance of the wheelhead is made, and the rotation backwards and forwards repeated, taking care to stop whenever small particles of the wheel break away. These can be felt, even if not seen, and must be removed immediately or damage to the thread form on the wheel will result. This operation is continued until approximately .002 in. beyond the thread depth has been reached. Further crushing beyond this point, however, will have no detrimental effect on the wheel, as it will only tend to harden

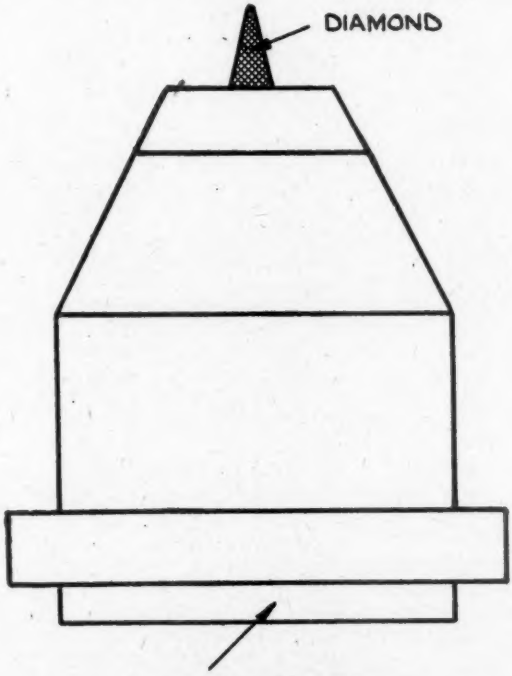


Fig. 10

the form—a sort of " glazing " effect. During all of these dressing operations on both machines, a copious supply of coolant must be directed at the intersection of the wheel and diamond, or crushing roller. As with the precision machine all that then remains is to take a test piece of the wheel form prior to setting the machine to the diameter and the helix angle of the thread to be ground.

These then, are two of the methods by which thread forms are crushed into grinding wheels. Wheels formed by these methods will have a very long life, as will be seen from actual results quoted later in this article, therefore they are most suitable for production work. It should be pointed out, however, that although their accuracy of form is of a high order, they cannot be relied upon to produce accurate thread gauges within extremely fine limits. Furthermore, this method demands that a suitable crushing roller for every thread form required shall be available. For fine limit production of ground threads, the purely diamond dressed wheel is necessary. With the aid of the patent Matrix Multi-ribbed diamond dressing attachment grinding wheels can be dressed to a high degree of accuracy of form, and wheels formed by this method are usually very free cutting. The attachment mounted on the table of the machine is driven through a splined shaft coupled to the workhead, and with the aid of suitable cams, the diamond while traversing profiles the thread on the grinding wheel. The wheel is first plunge cut with a specially formed vee diamond (Fig. 10) at the pitch required, profiling with this same diamond then follows, thus removing the major portion of the thread form on the wheel. Finally, this vee diamond is replaced by a patented " Cone " diamond (Fig. 11), accurately lapped to clear the thread, which is profiled round the form on the wheel, taking very light cuts until the radii at crest and root are fully formed. This device is easily set-up for different forms of thread such as Whitworth, B.A., U.S.S. Buttress threads, etc., and is therefore extremely useful when dealing with small quantities covering a large variety of thread forms.

In addition to the above, there is, of course, the single-rib wheel method. This also is very useful for small quantity production, or where irregular thread forms are required, and furthermore, can be used to advantage on sharp vee forms. Obviously, a grinding wheel dressed in this manner, will not have the same life as one dressed by the multi-ribbed methods, therefore a more frequent inspection of the product is necessary.

It was mentioned at the commencement of this article, that it was largely due to the developments in the production of suitable grinding wheels that thread-grinding has made such rapid progress in recent years. The grinding wheel manufacturers have made a close study of the problems presented in maintaining an accurate thread form, and it is due to their efforts that we have available to-day,

a grade of wheel that can be relied upon to give good service. It has been found that the Vitrified type of bond is most suitable for thread-grinding, among the advantages claimed are the removal of material without over-heating and their porosity which allows the coolant to be used most effectively. With regard to the grain

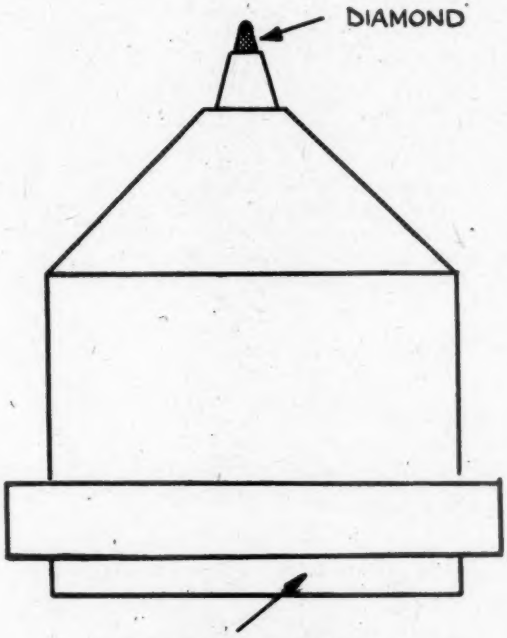


Fig. 11

or grit size, there would seem to be some diversity of opinion. It is the practice of some manufacturers to reduce the grit size to suit the thread being ground. Fine pitches—fine grit; and wheels up to No. 600 are obtainable (i.e., the figure " 600 " represents the number of openings per linear inch in the screen used to size the grit, and for sizes from 300 upwards, hydraulic separation is used in their classification). With these very fine grit wheels, however, there is a tendency for the grits to break away during dressing. In the opinion

of others, grit size is not of major importance. One well-known user employs a 220K wheel to cover all B.A. sizes from 0—12 B.A. inclusive. It is very difficult to lay down any concrete rule as to the wheel most suitable for general purposes, a lot will depend on the material of the component, the speed and feed of the grinding wheel, and the pitch of the thread, but for general work on hard materials a No. 320 L: has been found to be very efficient, whilst for soft materials 180 K. or 220M. will give good results. It should be mentioned, also, that trouble is sometimes experienced with grinding wheels failing to hold the thread form. This is traceable to faults in either the mixture or the kilning operation, and the wheel manufacturer should be consulted.

Whichever grade of wheel is decided upon, however, good results from thread-grinding will depend to some extent on the coolant used. Oils such as Duckham Q.3461 or Shell-Mex M.5 have been specially developed by the manufacturers for use with thread-grinding machines, and are equally satisfactory for both crushing and grinding operations. It will be found more economical to use the same oil for both operations and thus obviate the draining of the coolant tank after crushing, which would be necessary if another grade of oil were used as the coolant. The oils mentioned above are on the " thick " side, this being an advantage, as if too " thin " an oil is used, softening of the wheel results, and it will be found impossible to maintain the thread form. Therefore, since most oils tend to thin when used continuously, it is advisable to regularly drain the tanks and pipes, and to re-fill with fresh oil. For the grinding of extremely accurate work, a soluble oil is preferable, due to its better heat conduction properties.

The above remarks are intended only as a general description of the methods employed, it being realised, that in the space available the full technique of thread-grinding cannot be covered. So far, the economics of thread-grinding, types of machines, dressing methods, grinding wheels and coolants have been touched upon. It is now proposed to deal briefly with some of the troubles to be expected when thread-grinding, and to give some indication how these may be overcome.

To obtain the best results and to eliminate a major cause of many troubles with thread-grinding machines, as with any other type of machine from which accurate work is expected, the choice of site and the installation play an important part. A charge sometimes levelled against the introduction of thread-grinding, is that high maintenance costs are incurred when using such fine diamonds for the wheel-dressing operation. Breakage of diamonds is in many cases directly traceable to vibration from adjacent machinery, or to a " live " floor, therefore a firm foundation is essential. It is necessary too,

that the machine is correctly levelled and that all electrical and mechanical rotating parts are in dynamic balance when installing. Excessive end-play in the wheelspindle bearings and too heavy a feed when dressing are contributory causes of diamond breakage. Chatter marks on the flanks of the thread can often be cured by

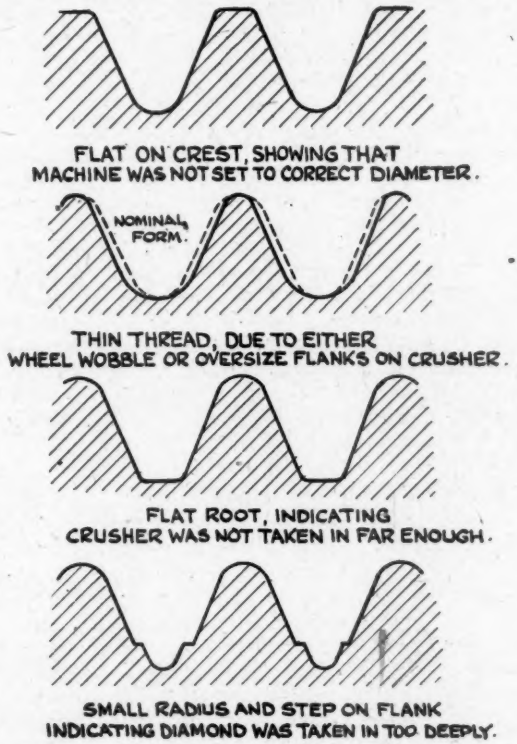

FLAT ON CREST, SHOWING THAT
MACHINE WAS NOT SET TO CORRECT DIAMETER.
NOMINAL FORM.
THIN THREAD, DUE TO EITHER
WHEEL WOBBLE OR OVERSIZE FLANKS ON CRUSHER.
FLAT ROOT, INDICATING
CRUSHER WAS NOT TAKEN IN FAR ENOUGH.
SMALL RADIUS AND STEP ON FLANK
INDICATING DIAMOND WAS TAKEN IN TOO DEEPLY.

Fig. 12

attention to the spindle end play, in this connection it is recommended that the end-play should not exceed .0002 in.

Faulty thread forms, providing that the above points have received attention are usually traceable to the dressing-operation, or in the case of the crushed form, to the crushing roller used. Wheels that have been profiled with a diamond should reproduce an accurate

thread form, providing that a badly worn diamond is not used, and that the in-feed has been set correctly, to cover the full depth of thread. When using the crushing process, however, wear on the rollers must be taken into consideration. The wear, on an annular grooved crushing roller, differs from that which takes place on a helically grooved type. In the former instance, it is greatest on the crests of the thread form on the roller, whereas in the latter case, it is the flanks of the thread that wear most. This has led to some users designing the thread form of their rollers to provide some wear allowance.

With the helical grooved type, however, it is problematical whether this is advisable, since a full thread on the crusher produces a thin thread on the wheel, this in turn reproduces a full thread on the job, and the life of the wheel is reduced to a minimum. Thus it has to be decided whether the lengthening of the crusher life is to be preferred to that of the wheel form. It is important at the same time to remember that crushing rollers should always be treated as precision tools, they are the masters which will control the form of the thread to be ground.

A few examples of the type of malformed thread likely to result from a badly crushed wheel are shown in Fig. 12 and an examination of these will indicate their cure. As an example of the results that can be obtained with a correctly crushed wheel, the tabulated information from actual production runs, given at the end of this article, will no doubt be of interest.

In conclusion, it is hoped that the foregoing brief description of some of the aspects of thread-grinding, has served to extend an interest in the possibilities of this modern method, for the production of accurate screw-threads.

T.P.I.	Thread form	Length ground	Wheel used	No. of crushings	No. produced	Average time per piece in mins.	Effective diam. tolerance maintained
59.1	B.A.	$\frac{1}{8}$"	320L.	2	1150	$3\frac{1}{2}$	.0009"
47.9	B.A.	$\frac{7}{8}$"	320L.	3	1775	3	.0009"
38.5	B.A.	$\frac{15}{16}$"	320L.	once only	2480	$2\frac{1}{2}$	.0011"
* 26.0	Whit.	$1\frac{1}{8}$"	220M.	,,	200	4	.0005"
31.4	B.A.	$1\frac{1}{16}$"	320L.	,,	1800	$2\frac{1}{2}$	.0011"
28.2	B.A.	$1\frac{1}{8}$"	320L.	,,	750	$2\frac{1}{2}$	.0012"
25.4	B.A.	$1\frac{3}{16}$"	320L.	,,	600	$2\frac{1}{2}$	.0012"

* With this exception, all of the above parts were made of hardened silver steel.

NEW TOOLS FROM SCRAP HIGH SPEED STEEL

Paper presented to the Institution, Coventry Section, by U. F. T. Norris, A.M.I.P.E.

THE situation in which engineers responsible for tools have found themselves during these days of acute shortages of the necessary materials and the labour required for fabrication has resulted in considerable economies which were, for one reason or another, either overlooked or disregarded in times of greater supply.

Luckily redundant or partly used tools do not deteriorate, and this fact in combination with the stocks which seem to accumulate around machine tools, in operators tool cupboards and elsewhere, are to-day being turned to good account, and to my personal knowledge have been the only means of maintaining vital war production in many instances. There is no doubt that insufficient attention has been given to the provision of adequate tool supplies required for such a tremendous employment of new machine tools and the diversion of so much semi-skilled and unskilled labour as is known to-day. This, coupled with increased machining difficulties arising from a greater tendency to encounter hard spots and inclusions in stampings, forgings and bar has reduced tool life at a time when the replacement problem is at its most acute stage.

Many production engineers will have gathered from time to time that managements responsible for machine shop output are reluctant to be "put off" by excuses that machine stoppages are due to absence of available tools. They do not seem at all happy to have valuable plant and labour idle when all that is required to maintain the hum of industry is a small piece of metal either square, round or with a fascinating twist like a Jacobean chair leg. In addition to the shapes just mentioned there are, of course, many tools in shape unlike anything else on earth. All these difficulties can be overcome to a very large degree by making new use of so much idle tool steel—already in existence and at hand.

The re-fabrication of straightforward turning tools was undertaken as a first step following an arrangement with the shops to return to stores all scrap material which was of standard pre-war tungsten content and which had been discarded when too short for the existing tool boxes or because in the case of form tools

Coventry, April 9, 1943.

the shape had served its normal life. At a later stage the set up was expanded to include the making-up of end mills, reamers, spot facing tools, etc., also from scrap ends of suitable dimensions. A standard shank material is required and is not difficult to obtain being offered with a .5 carbon .6 manganese content through the usual suppliers of alloy steels. This material as purchased is oversize from the final rolling operation—some .025 in. remaining to enable tools being ground all over to standard sizes where necessary. The main reasons for special shank steels are the need for a material that is sufficiently stiff to take the cutting load on the tip or welded end without bending and which will possess a rate of contraction similar to that of High Speed Steel so as to avoid rupture of the weld in cooling.

For the same reasons all tungsten carbide tips are mounted on this special shank material. Considerable quantities of worn out or damaged tungsten carbide tipped tools were collected and the shanks were used to produce tools of the butt welded type which consist of a shank to which is electrically welded a high speed steel end of equal section. The cracked, broken or worn tips are removed. This may be done by de-brazing or reheating on one of the usual type of electric tipping machines.

Probably the simplest and cheapest method is to dissolve by dissolving the braze in Nitric acid. A shallow bath containing a 40% solution with a specific gravity of 1.2 can be filled with the tools and left overnight. If possible the bath should be maintained at a temperature of 125°F.—and after copious washing in cold water the tips come away. Obviously tip fragments of suitable size can be re-mounted and re-ground for further use and the useless pieces collected for sale—for which 2/6 per lb. will be paid by centres set up by the Iron and Steel Control for receiving it and from which the tungsten is reclaimed.

Tools of the butt welded type have always been marketed under well-known trade names and it has been standard practice to have welded shanks on drills and reamers above certain diameters.

Having set up a salvage stores—all scrap, redundant and obsolete tools are sorted and put aside in bins under separate headings, tool steel sections, worn hobs, reamers, taps, rivet snaps, broaches, milling cutters and drills. In this connection care should be taken to see that separate spaces are provided for materials with differing tungsten content. It will be easily seen that a batch of new tools made up from different scrap will have disappointing results when given a standard heat treatment unless these precautions have been taken. Careful sorting is of the greatest importance, and good fortune—and perhaps some foresight in an attempt some years ago

to standardise on 18–4–1 High Speed Steels for tools—has made the problem in the case in question relatively simple. When there is a mixture of carbon or low tungsten content tools to be handled the cheapest method of sorting is by the well known spark test.

Any standard grinding wheel of medium or fine grain will indicate by the colour of the spark (particularly if used when the light is not too good) whether the steel is tungsten or carbon, and with a little experience one can become quite reliably expert. Sparks from steel have a forked shaped head—the fork from the low carbon steel being of simple form, the form becoming more complicated with increased carbon content. The spark from tungsten steel has a curved thickened point resembling the shape of a packing needle. In addition there is considerable difference in colour and volume of sparks. For carbon steel the volume of sparks is considerable, remaining white both at the point of wheel contact and at the far end of the stream. For High Speed Steel the volume is small and changes from red to straw. Incidentally, tinted glasses are of some aid in making spark colours more easily distinguishable.

Having collected and sorted materials it now remains to set up the actual manufacture of replacement tools from the source provided and one or both of the following methods may be adopted :—

(1) Flash Butt Welding.

(2) Tipping.

For the manufacture of butt welded blanks the main items of equipment required are :—

(1) Abrasive cut-off machine (Where not available a hack saw machine will serve providing scrap tools are previously annealed).

(2) Butt Welding Machine.

(3) Furnace for equalising temperature of welded area and shank.

(4) Tray for slow cooling in Keiselguhr or spent charcoal.

(5) Furnace for full annealing.

It will be necessary to provide copper jaw blocks of design to suit different sections of shanks and tips and having set up the machine, as big a volume of blanks should be welded as can be arranged. Different machine tappings are selected to suit areas of material to be welded ; the jaws to be used can be numbered and the tappings recorded to form a guide for repeat set ups.

The batches of shanks and slugs are cut to length and sandblasted or pickled to remove scale so that they will provide good electrical contact with the copper jaws They then pass through the welding and annealing process and into stock as butt welded blanks in the fully annealed condition for issue to Tool Room for conversion to

the shape and size required. Where cranked or off-set tools are required the forgoing is done after welding and before hardening.

In preparing the slugs and shanks it must always be remembered that a loss of overall length of up to ½ in. will take place during the welding. This can be governed to some extent by the adjustment of the length left projecting from the welding jaws—a usual proportionate loss amounting to $^{5}/_{16}$ in. of the shank plus $^{3}/_{16}$ in. of the High Speed Steel.

Many advantages are gained even when working in small batches and a relatively small range of sections and lengths can be adapted to cover average requirements in the shop. Remembering that the shank material can be salvaged from worn-out carbide tipped tools, it is not a great loss to make all tools to one or two standard lengths, the soft shanks to be cut after issue to suit varying tool boxes.

By the alternate method of tipping we have an outlet for many of the smaller pieces which remain after cutting solid high speed tools into slugs for welding, and in addition a use for worn out blades from inserted tooth type of reamers and milling cutters and for worn out die and chaser blanks.

The tipping of shanks with small pieces of scrap High Speed Steel while not possessing some of the advantages of the solid welded tool, offers a simple means of producing tools of a type which have always been available and accepted as satisfactory under trade names.

The employment of a small milling machine or shaper and a simple brazing hearth will provide for the machining of the tip seating and the securing of the tip in position. It may not always be necessary to seat the tip below the surface of the shank, there being no reason why the tip in some instances could not be secured to the top of the shank.

With the more recently developed welding powders a remarkable fusion is obtained between the tip and the shank; in fact, it has proved to be extremely difficult to remove tips which, as sometimes happens, are affixed to the wrong shanks or otherwise misplaced. These powders will withstand the temperatures employed for hardening the tips and the tool may be transferred direct from the muffle to the quenching bath for hardening.

The shank end is heated to about 800°C. and withdrawn from the muffle so that a small amount of the welding media may be sprinkled on the tip seating. The tip is placed in position with an additional small quantity of powder on the top of the tip and the whole returned to the furnace and brought up to the hardening temperature of the tip. As soon as the powder melts the tool is withdrawn, the tip pressed firmly into the seating and the whole tool quenched.

Care should be taken to see that the tips overlap the sides and end of the shank to allow for grinding after hardening to remove the decarburised surfaces resulting from open air hardening. Always give ample support to the tip, which should not exceed in thickness a dimension greater than 25% of the shank thickness.

Very little further work is necessary on either type of tool beyond providing flat faces on the bottom and the top of tools to ensure a good seating in the tool box. Regarding clearances and rakes, for standard turning tools a simple standard of 5° front and side clearance and 10° top rake leaves them in reasonable condition for final grinding in the shops to suit the individual tastes of setters and operators.

Considerable experience has shown that however a tool is finish ground almost the first thing that happens is that the person into whose possession it falls will take it along to the nearest tool grinding stand and make some adjustment to it.

When deciding on the standards of sizes, etc., to be made up, pay full attention to the advantages to be obtained from tools as big as possible. It is a waste of time to attempt machining with an undersize tool. If possible open up tool box sizes—always employ the biggest and best tool that can be obtained. The performance of machine tools is ever increasing—modern spindles are more rigid and run faster—yet poor provision is made to enable that vital link—the tool—to meet the work expected of it.

In addition to general turning tools the butt weld process is applied to the manufacture of end mills, spot facing cutters, counterbores and rivet snaps. A stock of shank steel of the most useful diameters will enable such scrap items as broaches to be utilized if annealed and cut up into short lengths.

It is important to remember that a number of high speed steel broaches have a low tungsten content, sometimes only 3 or 4%—and are therefore not suitable for conversion into high duty tools.

The question of reconditioning such items as rivetting snaps used with pneumatic hammers, etc., is mentioned in passing as this results in a saving of labour rather than material. As these tools are continuously reworked to maintain the correct shape of the rivet head they ultimately become too short and rather than turn a complete new tool from $1\frac{3}{8}$ in. dia. special bar a short length of $^{15}/_{16}$ in. dia. equivalent material is attached thus maintaining the original lengths. Short lengths of scrap broaches and other round high speed steel are used to build up pilot reamers.

It will have been realised that the shank material described cannot be hardened, nor carburised satisfactorily, but success is being achieved by hard chrome plating and grinding of pilots after hardening the high speed steel section.

In dealing with reamers and taps there seems little to be gained by further expenditure on those that are broken. All worn ones are sorted, annealed and passed to the women's trainee section of the tool room to be turned down to regular sizes. In the case of reamers these are then turned, refluted and left .030 in. oversize, hardened and put in stock to be withdrawn and ground as required.

Taps have the worn threads turned off and are refluted, rehardened and put into stock under the new size headings for withdrawal when sufficient quantities are available to be thread ground.

Milling cutters can be reclaimed in either of two ways—by softening, regashing, and re-hardening or by regashing in the hardened condition on a shaped grinding wheel—preferably a good big wheel, say of 20 in. dia.

Some misgiving may arise as to the bore condition of cutters after annealing and re-hardening, but in practice very little movement takes place—there may be some increase in bore size to a maximum of +.001 in. due to loss by scaling in annealing and rehardening, but as the cutters will in so many instances be put to work on arbors that are far from new the variation is immaterial.

Where cutter teeth are broken off or damaged—a process of building up by atomic hydrogen welding is successful. Welding rods may be made up from discarded portions of high speed drills and taps—joined together into suitable lengths. Cutters should be preheated to 400°—500°C. before welding to avoid cracking. No flux is required for this process, and subsequent heat treatment is unnecessary. Arc welding with special anodes is an alternative recovery method.

Hobs are an attractive source of good material at the end of their normal life and particularly as such tools are generally made from forged and up-set blanks. After removing the teeth they can frequently be converted into shell reamers or taps.

The application of hard chrome plating to gauges for the purpose of increasing resistance to abrasion and for the recovery of those worn undersize is familiar to everybody in these days. There are, however, other applications which can be very profitable. When hard-chrome plating of broaches or reamers is contemplated it is advisable to grind a little more back relief on the teeth so that cylindrical grinding is only necessary to reduce the plated diameter to the required size. This leaves the full depth of plated deposit to support the deposit on the cutting edges.

Taps used on cast iron generally fail due to the lapping effect of the swarf when running the tap out of the hole. A flash plating of

hard chrome of about .0002 in. will not, in most cases, seriously interfere with the pitch diameter but will considerably increase tap life.

A new file recently tested on ebonite gave a life of only 400 components. After flash chrome plating a similar file produced 2600 pieces.

Do not confuse hard chrome depositing with the normal chrome plating used commercially for corrosion resistance.

There is one other method of using high speed scrap to build up tips on tools—but at the moment the development has not been completed, although demonstrations have taken place with the experimental apparatus. In this process high speed steel in the form of broken drill ends and pieces too small for normal reworking can be melted by a carbon arc and allowed to run into a mould surrounding the tip seating on the shank. Tips made by this method give promise of good performance and merely require grinding before being put to use.

All points in the foregoing remarks are equally applicable to either the high tungsten steels, or the newer substitute materials. It is only at the hardening stage that any variation in treatment is necessary.

These are days of austerity and tools frequently lack the high finish that pleases the eye, but this can be sacrificed provided the performance maintains production

Despite the fact that the hardening of High Speed Steel is a subject to which justice could only be done in a paper devoted to the subject alone, the process demands at least some comment as it is the most vitally important operation in tool making. The most efficient craftsmanship is valueless unless the correct materials and heat treatment are combined in the finished article.

Maximum temperatures for quenching are governed by the materials being utilised and so are the times of exposure to those temperatures. The great point is that time and temperature are more critical than is generally appreciated—time to within limits of seconds and temperatures to within ten degrees.

For machining average materials where high speed steel tools can be applied it is better to standardise on 18-4-1 or the new substitute steels and vary the heat treatment in preference to adopting the different classes of steel containing high cobalt contents, etc.

The secondary hardening or tempering treatment—sometimes neglected altogether—is of tremendous importance in obtaining maximum performance and should be sustained for at least 1 hour at temperature.

An additional application of this treatment after a 12 hours interval is of advantage and still further gain may occasionally be obtained by tempering at low temperatures for 3 or 4 hours.

The Rockwell control—whilst not indicating whether a tool will cut or not—does certainly indicate, if the readings are taken after the initial hardening and again after the secondary treatment, whether the treatments have been carried out in a satisfactory manner.

Do not be discouraged if first attempts at welding or heat treatment are unsatisfactory. It is never possible to begin just where the the other fellow has left off. There is plenty of sorrow and grief at the disposal of providence, and much is left to be found along the path trodden by the pioneer setting out to develop new or increased economics.

As a last word—be advised to make the very best tools that are possible. It is not more tools that are needed—but frequently bigger tools and at all times better tools.

Give the shops a slogan—DON'T BREAK THE TOOL—GIVE THE TOOL A BREAK !

Due acknowledgment is gratefully made to the Production Engineer of Messrs. Vauxhall Motors Ltd. under whose control so much of the subject matter dealt with in the foregoing remarks has been developed.

Discussion

MR. FIELD : I am very interested in your acid bath for removing tips. Would that acid bath be useful for removing cemented tips ?

MR. NORRIS : I don't think so. I referred to the brazed tips particularly. We have no experience of the cemented tip.

MR. BOYES : You spoke of preparing tools and tips by careful grinding before presenting them for welding. Then you said that the tips would lose about $^{5}/_{16}$ in. and the shanks about $^{3}/_{16}$ in. off their length.

MR. NORRIS : The other way round, actually.

MR. BOYES : Is there any necessity for accurate grinding ?

MR. NORRIS : We don't.

MR. BOYES : Then what about flux ?

MR. NORRIS : We don't need any flux. You bring the points together and make and break contact until you get your heat generated, and then you pull the points hard together—just as the old blacksmiths used to do the chainlink business by hand. It is a mechanical adaption of hand forging.

MR. ANSTEY : There are some aspects that interest me ; particularly the size of the plant to deal with the job and when would it pay to install that plant. For what quantities of tools would you consider it necessary.

MR. NORRIS : To take care of the last point, the Ministry have set up centres for butt welding where you can send your shanks and tips to be done. We do not issue a new tool unless we get the old one back. Thus they come back to a central point, and a girl does the sorting. When cutting off on an abrasive wheel or a hacksaw it's only an hour or two's work to cut a hundred of these.

We were purchasing solid tools at the rate of 11,000 a year before the war ; of course, our demands have gone up very considerably and we are now making 20,000 a year ourselves. The butt welder is used for perhaps two or three hours a day only. Actual welding time is remarkably short ; for some of the sections shown here the welding time would be 13 seconds. One is governed entirely by the annealing capacity that you have ; you've got to fully anneal the tools after the first temperature equalising treatment, and that is something which should be done with any high speed tool which is fabricated, anyway.

MR. LEE : Is there any great importance attached to the squareness of the faces ?

MR. NORRIS : It doesn't matter what shape they are. The burning will commence at the highest two points. They will burn themselves away until the whole surfaces are in contact.

MR. SYKES: This is not a new thing by any means, is it? It has been in vogue now for years, and I suppose it has now gained in importance because necessity is the mother of invention. But for the war, do you consider that on tipped tools it would have paid any motor car firm to tip their own at the price that was prevailing previously? We are faced with the question of its taking such a long time to get tools. We are already using this process ourselves, but there is one thing I would like to ask you; I don't consider that on a lot of tools it is an economical proposition. For instance, with a 2 in. twist drill with a straight shank, what would you advise doing with that?

MR. NORRIS: Nothing; there is nothing you can do with it except melt it down or use it up as welding rod.

MR. G. E. WHITEHOUSE: Regarding the previous speaker's query concerning a drill being worn down, would it be practical for him to weld a High Speed deposit along the land, as they recommend with reamers?

MR. NORRIS: You've still got to grind it. I haven't given any consideration to that at all; probably on all drills, if they are big enough, it might pay. You are governed by the fact of economy in size. If you get a lot of wear on drills, why not get a flash chrome plate put on the lands? It gives a much harder Rockwell, if you don't put too much on. If you put too much on it will flake off. It will put your Rockwell up to 70 instead of 63/4; it *must* be hard chrome though, not ordinary chrome plate.

MR. H. A. DRANE: What would be the relative cost of a reamer such as you have got there and the one you have treated? You have been speaking about flash chroming and I understand you have got a file there which has been treated. I was under the impression that Chromium does not withstand shock; I don't know whether I misunderstood a lecturer we had previously—he said that even on the end of a pilot gauge you should not have chromium, because it would chip off.

MR. NORRIS: That isn't true. I believe I know who made that statement. He made it elsewhere and was immediately picked up by a number of people. With regard to this particular reamer, once we have worn it down .001 in. undersize, we chrome plate the lands and we get 7,000 cast iron piston gudgeon pin holes from it. The reamer costs somewhere in the region of 43/- if purchased outside; it costs us 14/- to chrome plate it and grind it, and we get 7,000 more components as against 10,000 when new.

MR. LEE: What is the finished thickness of the chrome?

MR. NORRIS: From .001 to .002 in.

MR. BOYES: What material are you using the reamers on?

MR. NORRIS : Cast iron.

MR. BOYES : Would the chromed reamer cut other materials as well as cast iron ?

MR. NORRIS : Speaking without any facts to guide me, I should think it would be better.

MR. HORTON : We have tried plating to a specific thickness of about .025 in. and we have not had much success with it.

MR. NORRIS : Too thick ; the thinner the better.

MR. T. SYKES : Is there any reason to think that a spiral reamer, right-hand or left-hand, would be any different from your straight reamer ? Why have you got a straight reamer there, when I should imagine a right or left-hand spiral would give better results ?

MR. NORRIS : They are much easier to grind !

MR. H. D. S. BURGESS : Extending Mr. Anstey's question a bit, in relation to the volume of employees of the company. How many people have you on the whole of this reclamation in relation to the employees of the company ?

MR. NORRIS : It is difficult to give any figures ; so much is done in conjunction with normal tool stores work and the jobs go through in batches in a Trainee portion of the Toolroom. With our present Control of tool purchase, issue and records, etc., about 80 people keep all the supplies up for about 12,000 operators. The number of people employed on any job depends on the load to a large extent. Where shops are spread apart you want a lot more centres for for distribution. On this reclamation job, I could give you another figure which may be interesting. In the course of last year we had an accountancy set up, where we charged all time on making tools from scrap to a common account ; this showed a profit of over £3,000 against the pre-war cost of these tools.

MR. H. A. DRANE : What is the smallest tool section you do ?

MR. NORRIS : Machine hacksaw blades when they break near the end.

MR. H. A. DRANE : On an ordinary turning tool with a tip on the top, you do not consider it necessary to have any backing at all ?

MR. NORRIS : Not a bit.

MR. W. THOMAS : Would you consider the chrome treatment of your reamer applicable to a Side and Face Cutter, giving, as it does, a more intermittent cut than a reamer ?

MR. NORRIS : Yes, I think so, because it is common practice to chrome plate broaches. Before putting this deposit on you must further relieve the top cutting edge.

MR. W. THOMAS : To what extent ?

MR. NORRIS : We give it plenty in the ordinary way, in order that after re-grinding there will be no danger of a feather edge.

MR. W. THOMAS: Regarding the substitute high speed steels, such as "46" and "66" can they be used for butt welding the same?

MR. NORRIS: Yes, just the same.

MR. W. THOMAS: Although the temperature is less, isn't it?

MR. NORRIS: Yes, for hardening, but it is just the same for butt welding. The reason for dropping the temperature in hardening is that you are apt to lose the molybdenum content.

MR. GUTTERIDGE: Can you give me the approximate price of one of these butt welders, and also a reliable firm that mades a good one?

MR. NORRIS: Up to what area would you propose to butt weld?

MR. GUTTERIDGE: About 1½ in. square—say 2 square inches.

MR. NORRIS: A No. 6 Holden & Hunt—costs about £280.

MR. MARK: If you take a long pilot reamer and butt weld the pilot to the shank it distorts and bends.

MR. NORRIS: Maybe it would with a weak section.

MR. MARK: If you chromed it and it was not perfectly staight, when you regrind it you may get an unequal surface of plating.

MR. NORRIS: That would not matter. As long as your plating was finished ground and true with your cutting teeth it doesn't matter.

MR. MARK: A lot would depend on how accurately it was straightened then?

MR. NORRIS: There is no reason why you shouldn't straighten it and build up heavily. You can put .02 in. on if you wish on a pilot diameter; some plug gauges, after building up, have .04 in. of plating.

MR. HARE: Does a form tool lose its shape after tipping?

MR. NORRIS: I would not like to be sure that it did not, because the hardening method is so bad.

MR. HARE: Is it possible to tip a milling cutter, as opposed to butt welding?

MR. NORRIS: I should imagine you could.

MR. HARE: Is it possible to tip a blade?

MR. NORRIS: Yes; you would have to do it in one special way, by copper bath as is used in making expanded reamers which have a small piece of high speed steel in front of each tooth. You can make it by putting separate teeth all the way round; generally wired into position and put into a copper bath at the hardening temperature and get no decarburisation or oxidisation.

MR. JACKMAN: Can you help me with regard to rivetting snaps; we get serious trouble with the shanks that go into the hammer, apart from the wear on the snap.

MR. NORRIS: In view of that you would have to butt weld a piece on to each end. You must be using the wrong steel; we have never

had trouble with these. We put $^{7}/_{16}$ in. and $\frac{1}{2}$ in. rivets into truck frames.

MR. WHITEHEAD : Would you mind deliberating further on that carbon arc depositing.

MR. NORRIS : Actually, we have made an effort to use up scrap drills and pieces that are too small for any other use, by melting them with a carbon arc, melting them and puddling them into the surface of the shank and building up a tip. It is not 100% yet, but it shows promise.

MR. WHITEHEAD : This tip would be useful if you came up against a very hard material, wouldn't it ?

MR. NORRIS : It probably has hardness properties somewhere between High Speed Steel and Tungsten carbide. The temperature taken to melt the scrap seems to do away with the need for hardening.

A VISITOR : With standard twist drills, would the twist have to be taken off ?

MR. NORRIS : No, it doesn't matter what its shape, but you would get a shock when you saw what had appeared to be a lovely piece of high speed steel reduced to a very small tip. The actual volume of metal in the fluted portion of a drill is very small.

A VISITOR : I understand that clinks are a serious disadvantage in butt welding.

MR. NORRIS : They are when you start.

A VISITOR : I take it that has been more or less overcome now ?

MR. NORRIS : Yes, definitely ; we do not get 2% failures. There is the question of the time lag in getting it out of the jaws and into the furnace. The evidence is a black area round the edge of the fracture, due to the varying rate of contraction, and failures always occur on the high speed side of the weld.

A VISITOR : Which, in your opinion, is the better tool, the one that is butt welded ?

MR. NORRIS : Yes, the butt welded has a much longer life. In the case of a form tool, if you grind a form on the end you have got 3 or 4 times the life.

A VISITOR : Is it necessary to degrease the tips before they are put on ?

MR. NORRIS : No ; nor is it necessary when using the newer tipping powders to get that good surface we used to worry about.

A VISITOR : Would you mind explaining further the idea of putting you tool into the furnace, heating to 800°C. and then putting the powder on after that ? Could not the powder be put on first ?

MR. NORRIS : Yes, I think perhaps it could. But you have still got to use two temperatures ; If you take the temperature of your tool staight up to your maximum, you will get a percentage of sweating from the steel, which oxidises the surface of the shank under the tip.

A VISITOR : In this butt welding ; you have a small piece of high speed steel. How do you hold a piece about 1 in. long when you weld it ?

MR. NORRIS : By letting it stick out in the jaws, that is all.

A VISITOR : What is the minimum size you can hold then ?

MR. NORRIS : You are governed by a stop, so that the tip will not be pushed back along the jaws, which have a platform in them for location.

A VISITOR : So jaws have got to be made to suit the tools you are doing ?

MR. NORRIS : To a large extent, yes ; and the machine that you would use for butt welding would vary in size according to the tools that you were doing.

A VISITOR : Could you weld say $1\frac{1}{4}$ in. square and then use the same machine to do $\frac{1}{2}$ in. square ?

MR. NORRIS : Yes.

A VISITOR : Can you do it the other way round ?

MR. NORRIS : No : until you discover all these things by experience you get all sorts of peculiar effects. Adjustment of heat, etc., is necessary for change in areas being welded.

A VISITOR : We have experienced a lot of trouble with distortion when hardening form tools. Can the speaker suggest any way to overcome this ?

MR. NORRIS : You shouldn't experience such trouble—it is the hardening itself that is wrong. You may not know that the Sheffield Gas Co.'s students have developed a very good gas furnace, which uses a curtain of inert gas across the mouth. This curtain, having no oxygen in it, helps to maintain an even condition inside the furnace ; the nitrogen or hydrogen content can be varied at will. Form tools should be normalised before heat treatment.

The time factor in this work is very critical ; as an example, if you take a batch of drills and fabricate them in the same way, and put one in the furnace, leave it in say a minute and then take it out and give a second treatment, you will get one result, but put another one in and give it only 10 seconds longer and, although the manufacture of the drills was identical, you will probably get quite a different result.

MR. A. J. FREEMAN : I should like to know your opinion of the correct temperature for hardening the average high speed.

MR. NORRIS : If you are talking of 18% Tungsten, a range of from 1240-1300 is normal. Vary that range according to the hardness of the material you are going to turn. Keep your secondary treatment in line with that.

A VISITOR : What about the temperature of the tempering furnace ?

MR. NORRIS : Keep that down too ; 560/585 is about the range.

A VISITOR : What would be the effect if we went any higher ?

MR. NORRIS : I don't know ; we have never found any better results from going higher.

MR. W. THOMAS : Would you, in all cases, advocate this second tempering ?

MR. NORRIS : Yes, it is essential for two reasons. Firstly, you set up so many stresses and stains in anything you harden. The second thing you do is to arrest the hardening process. Once you set up a changing condition it is difficult to know when it leaves off ; it grows brittle because the hardening process goes on. Whatever you do, give it a secondary treatment.

MR. FIELD : On the question of reclaiming this high speed steel. How many times do you re-harden it ?

MR. NORRIS : We don't know, but it is used over and over again. We do identify all tools which we have tipped ourselves, so we know when they come back a second time.

MR. FIELD : Will it degenerate in re-heating ?

MR. NORRIS : Yes, I should think it may, after the first time or two.

MR. W. A. RUSSELL : In connection with these temperatures for hardening, I believe there is a Ministry pamphlet (*Technical Bulletin* No. 12), giving figures and illustrations of tools butt welded, etc. If anybody is interested and will get in touch with me at Messrs. Rootes Securities Ltd., No. 1 Factory, I will give them details.

MR. BURGESS then brought the meeting to a close by proposing that a vote of thanks be passed to the speaker. In so doing, he emphasised the fact that Mr. Norris' connection with this subject had been a very practical one, extending over many years.

MR. NORRIS made a suitable reply, at the same time extending an invitation to anyone present who might wish to see something of this work to pay a visit to Messrs. Vauxhall Motors Ltd., Luton, where they would be most cordially welcomed.

Alternatively, the speaker was prepared to make sample welds free of charge, from scrap submitted, for anyone who wished to try these tools on their own work.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

NOTE.—*The addresses of the publications referred to in these Abstracts may be obtained on application to the Research Department, Loughborough College, Loughborough.*

ANNEALING, HARDENING, TEMPERING.

Quantitative Hardenability Testing of Steel, by Arthur E. Focke. (*Machinery Lloyd, July 10, 1943, Vol. XV, No. 14, p. 37, 10 figs.*).

" Jominy " end quench test specimens. Results of Jominy end quench tests on two medium carbon steels. Rockwell " C " hardness at indicated distance from water quenched end of standard test bar. Cooling rate at 1300°F. Relationship between cooling rate and distance from the surface for various sizes and shapes. Relationship between distance from water quenched end to critical hardness and ideal critical size (Grossmann). Conical specimen for shallow hardening steels (Green & Post).

FOUNDRY, PATTERNS—DIE-CASTING.

Die Casting Supplement, by H. K. Barton. (*Machinery, July 29, 1943, Vol. 63, No. 1607, p. 134, 4 figs.*).

Sprues, runners, and gates of die casting dies. Diagrams illustrating terminology used in die casting practice. Methods of ensuring an even distribution of temperature in the dies. Examples of sprue posts for interior feeds.

Mechanised Foundry : Flexible Materials Handling System, by Rolls Royce, Ltd. (*Elect. Rev., Feb. 12, 1943, Vol. 132, No. 3403, p. 205*).

Illustrated account of this light alloy foundry and the electrical control system.

(*Communicated by the British Non-Ferrous Metals Research Association*).

Die Casting with Zinc Base Alloys, by Edmund Bates. (*Industrial Gas Times, May, 1943, Vol. V, No. 68, p. 180, 4 figs.*).

Diagram of the burner equipment of the die casting machine. Rear view of machine, showing gas governor, control valve and flue. Operating the dies. Burner equipment. Heat utilisation. Temperature control. Die casting is becoming increasingly popular because of the high output obtainable and also due to the fine degree of accuracy that can be maintained over long periods.

MACHINE ELEMENTS.

Spindle Bearings for High-Speed Machine Tools—I, by Dr. G. Schlesinger. (*Machinery, July 22, 1943, Vol. 63, No. 1606, p. 100, 2 figs.*).

Considerations on bearings, friction and lubrication of machine tools. The main tasks of lubrication are :—(1) Elimination of wear, (2) Diminution of friction, (3) Decrease of oil consumption, (4) Increase of load carrying capacity. Essentials for effective lubrication.

MACHINING, MACHINE TOOLS.

Bar Support Tubes for Capstan Lathes. (*Machine-Tool Review, May-June 1943, Vol. 31, No. 185, p. 62, 7 figs.*).

Silent bar support tube as supplied with the automatic bar feed on capstan lathes and other bar machines. Liners should be used in the front end of the tube to prevent bars whipping and wearing the wood lining. Support bushes for round, square and hexagon bars. Damage to the corners of square and hexagon bars can be prevented by supporting the bars in a revolving holder. Revolving holder with support bush mounted in a needle roller bearing.

CHIPLESS MACHINING.

Design and Production Technique, Principles involved in shearing, by A. J. Schroeder. (*Aircraft Engineering, July, 1943, Vol. XV, No. 173, p. 207, 125 figs.*).

Shearing technique comprises the methods of production involving the tearing or ripping of material. Process of shearing. Formation of burr. See that shallow notches on parts to be embedded are rounded. Allow sufficient distance between blanks or from blank to edges of the plate. Aim at proper flanging of lugs by suitable shaping. Remember that there is a limit to the flanging of springy material. Components should be easily extractable. Depths of flanged holes depend on the diameter. Manufacture of shearing dies. Make the contour lines of every component as short and simple as possible. Select suitable shapes of holes. Unify the diameter of holes as far as possible. Provide for sharp corners when using compound tools. Observe economic dimensions. Facilitate assembly by suitable arrangement for subsequent shearing. Form the gaps simply. Keep the gaps open ended. Shape transformer plates practically.

Tolerances applied to parts to be sheared. Employ economic shapes and dimensions. Various possible arrangements of components out of material strip. Utilize the scrap material suitably.

MANUFACTURING METHODS.

Machining of Magnesium Parts 2 and 3, by A. M. Lennie. (*The Machinist, July 10, 24, 1943, Vol. 87, Nos. 12, 14, p. 88 and 82, 9 figs.*).

PART 2. Use the right tools: Drills for shallow holes. Drilling deep holes. Recommended reaming practice. Drawing of tools designed specifically for working in magnesium. When kept sharp, they produce high surface finish, permit high machining speeds, and at high speeds hold work heat to a minimum. A wide variety of mineral-oil cutting fluids can be used when machining magnesium. Water-soluble and oil-water emulsions, although good coolants, should not be used. Tools for automatic screw machines. Recommendations for saws.

PART 3. Proper machining practices prevent distortion and make the fire hazard associated with magnesium negligible. The fire hazard with grinding and polishing work can be controlled by using adequate dust-collecting systems The equipment must be designed to prevent the accumulation of dust or sludge in any location where it could dry out to an inflammable composition. Table of recommendations for polishing magnesium.

Development of Broach Rifling at Rock Island Arsenal, by William Baumbeck. (*Mechanical Engineering, U.S.A., June, 1943, Vol. 65, No. 6, p. 401, 9 figs.*).

Thirty-five operations required to produce a machine-gun barrel. Usual rifling method. Successful broach developed. Working details of rifling broaches. Cutaway view of assembled rifling head for calibre 0.30 barrel. Roughing and finishing broaches for gun barrel of Browning Machine Gun, calibre 0.30. Practical results obtained from use of method. Comparison of broach rifling and conventional rifling, based on rate of 40 barrels per hour. Inspection fixture for gun-barrel broach, calibre 0.30. Items included in total cost per barrel.

Radial Drill Press Operations, VII, VIII, IX, X. (*The Machinist, Reference Book Sheet, July 10, 24, 1943, Vols. 87, 87, Nos. 12, 14, p. 121, 123, 109, 110*).

Time to drill brass alloys. Time to drill cast iron. Time to tap cast and cold or hot rolled steel. Time to tap bronze alloys. Time to tap copper.

The Re-Conditioning of Worn Parts, as it Affects the Engineer, by J. A. Leonard. (*Power Transmission, July, 1943, Vol. 12, No. 138, p. 420*).

Methods of reclamation of worn components : (*a*) By the spraying of suitable metal on the worn parts. (*b*) By the electro-deposition of metal or metals. (*c*) By welding a new section on the component, or, alternatively, building up the worn section by welding.

War Winning Suggestions. (*The Machinist, July 24, 1943, Vol. 87, No. 14, p. 89, 8 figs.*).

Holder improves grinding of tap chasers. Plate hook solves safety hazard. Retooling saves one machine. Clamps hold painted sheets. Speeds set up of screw machines. Rubber plugs seal gas tanks.

Boston Line Assembly. (*Aircraft Production, August, 1943, Vol. V, No. 58, p. 385, 18 figs.*).

Extensive application of the moving track system by Douglas Aircraft : Pre-production organisation.

The Cheetah X, by J. A. Oakes. (*Aircraft Production, August, 1943, Vol. V, No. 58, p. 364, 31 figs.*).

Part I. Performance and design : Machining the crankshaft and master connecting rod.

The Manufacture of the Jerrican. (*Machinery, July 1, 1943, Vol. 63, No. 1603, p. 1, 13 figs.*).

Press shop operations in the production of an improved petrol container Stages in the production of body pressings : the drawing tools for the body pressings. Rebating tools for body pressings. Sectional elevation and plan of clipping tools. Piercing tools for the filler neck hole. The piercing and blanking tools for the handle. The closing tools for the handle of the Jerrican.

MATERIALS, MATERIAL TESTING.

Synthetic Rubber, by L. F. Marek. (*Mechanical Engineering, U.S.A., June, 1943, Vol. 65, No. 6, p. 412*).

With the annual production of nearly 1,000,000 tons of synthetic rubber at 35 cents per lb. the value of this ultimate annual production will approach

$ 750,000,000. The products differ from natural rubber in chemical structure and in some cases in chemical composition ; they differ in physical properties and in behaviour during processing. Three groups are participating in the major Buna-S programme, chemical and petroleum companies to supply the raw materials, styrene and butadiene, respectively, and the rubber companies to perform the polymerization to rubber and to manufacture goods from the product. Scope of programme and costs. Rubber situation. Tyre situation Background of synthetic rubber production. Synthetic rubber 1943. Types: Buna-S ; Butyl ; Neoprene ; Buna-N ; Raw-material sources. Properties and uses of synthetic rubber substitutes. (*a*) Higher resistance to gasoline, oil, etc., (*b*) Greater stability to light and air ; (*c*) Greater wearing quality ; (*d*) Higher sidewall strength ; (*e*) Greater road grip (frictional resistance greater).

Substitute for 90 Cu, 10Sn Bearings, by M. F. Garwood and E. H. Stilwill. (*Met. Progress, March, 1943, Vol. 43, No. 3, p. 396*).

Extracted from a paper " Material Applications in Gun Manufacture " read before the Society of Automotive Engineers. Two Cu-Si alloys (respectively 3.24%Si, 0.44%Fe, 0.68%Sn, 5.1%Zn, 0.02%Mn and 4.03%Si, no Sn, 0.10%Fe, 0.30%Zn, 1.05%Mn) were found satisfactory for bearings of the 40 mm. anti-aircraft Bofors gun.

(*Communicated by the British Non-Ferrous Metals Research Association*).

New X-Ray Evidence on the Nature of the Structural Changes in Cold-Worked Metals, by W. A. Wood (*Nature, May 22, 1943, Vol. 151, No. 3838, p. 585*).

A method of determining for any given metal which has been plastically deformed, whether the diffusion of X-ray reflections is due mainly to the breakdown of metallic grains or to permanent changes in atomic dimensions.

(*Communicated by the British Non-Ferrous Metals Research Association*).

MEASURING METHODS, APPARATUS.

Gauge Design and Dimensioning. (*Machinery, July 22, 1943, Vol. 63, No. 1606, p. 92, 12 figs.*).

The principles of design and of calculating tolerance limits. Analysis of faulty designs also synthesis of correct gauging of complex components Functions of gauges. Diagram showing disposition of gauge tolerances. Workshop and inspection gauge limits. Inefficient gauges for complex components. An improved design of gap gauge for a bevel gear. Efficient gauging of complex components. Gauges to control dimensions of a 4-start nut to workshop limits.

Recent Developments in Quality Control, by H. Rissik. (*Machinery, July 1, 1943, Vol. 63, No. 1603, p. 10, 8 figs.*).

Control limits and engineering limits. Relation between control limits, accuracy limits and engineering limits. Process accuracy v. working limits. Machine characteristics expressed as the frequency distribution of dimensions of parts produced. Relation between control limits and tolerance limits. The control ratio. Relation between tolerance factor and percentage defective. Application to a capstan operation.

Quality Control, by K. Hayward. (*Aircraft Production, August, 1943, Vol. V, No. 58, p. 359, 6 figs.*).

Although, hitherto, quality control has always been associated with mass production, the flexibility of the system allows its application with equal success to small-quantity output. This important feature, not yet fully appreciated, is brought out in the article, which described in detail the methods adopted by the Bristol Aeroplane Co. in their machine shops. Machine shop experiments. Training scheme. Q.C.-handbook. Application of system. Sample checks. Defectives. Specimen control chart.

Projection Inspection of Form Tools, by W. Stewart. (*The Machinist, July 24, 1943, Vol. 87, No. 14, p. 78, 2 figs.*).

Speedier production and more accurate duplication are made possible by projecting tool forms against 50 × drawings. Tolerances are held exactly on repeat orders and a working guide is provided while grinding is in progress. Hobs and special form tools are checked precisely by projecting them against large scale drawings mounted across the room. The inspection department is located beside the finish grinding room for the operator's convenience. All tool shapes can be checked.

METALLURGY.

Preparation and Properties of Cemented Carbides, by R. W. K. Honeycombe. (*Proc. Australasian Inst. Min. Met., New Series, Dec. 31, 1942, No. 128, p. 227*).

An orderly digest of published information, with a bibliography of 40 items. Preparation of carbides of W, Mo, Ti and Ta. Production of sintered carbides, including mixing of components, pressing of powder compacts, the presintering process, sintering of carbide compositions, control of physical properties of cemented carbides, carbide compositions for steel cutting tools, constitution of complex carbide alloys.

(*Communicated by the British Non-Ferrous Metals Research Association*).

PLASTIC AND POWDER MATERIAL.

Plastic Working of Magnesium Alloy Sheet, by C. E. Lehnhart. (*Iron Age, March 18, 1943, Vol. 151, No. 11, p. 45*).

Working temperatures, presses, dies, tools, lubricants, etc., used in the hot pressworking of Mg alloys.

(*Communicated by the British Non-Ferrous Metals Research Association*).

Production and Sintering of Powdered Cobalt, by E. J. T. Lumley, R. W. K. Honeycombe and J. N. Greenwood. (*Proc. Australasian Inst. Min. Met., New Series, Dec. 31, 1942, No. 128, p. 221*).

Purification of cobalt oxide; reduction to metal by hydrogen; sintering of Co-powder in hydrogen, with notes on density, shrinkage, hardness and microstructure of the sintered product.

(*Communicated by the British Non-Ferrous Metals Research Association*).

The Present Position of Powder Metallurgy, by R. Kieffer and W. Hotop. (*Translation from Stahl u. Eisen, Germany), June 13, 1940, Vol. 60, No. 24, p. 517*).

A general paper on methods of producing powders, sintering and types of products. Bibliography.

(*Communicated by the British Non-Ferrous Metals Research Association*).

RESEARCH.

Two-Stage Drawing of Cylindrical Cups, by Professor H. W. Swift. (*Sheet Metal Industries, July, 1943, Vol. 17, No. 195, p. 1179, 14 figs.*).

Redrawing from a cup. The redrawing process can be conveniently divided into three periods. During the first period the base of the first-stage cup is being bedded down onto the punch and die surfaces. During the second period material is being drawn over the whole of the conical surface of the die, while fresh material from the walls is being fed down on to this surface as redrawing proceeds. During the third period the outer rim is being drawn in from radius R_1 to R_2. Stresses during drawing-down period. Thickness changes. Experimental apparatus. Experimental methods and procedure. Redrawing tests. (*a*) guiding conditions ; (*b*) tapered dies ; Scope of experimental work. (1) Drawing loads and characteristics ; (2) Strains during drawing and redrawing.

The Application of Statistical Methods to the Quality Control of Materials and Manufactured Products, by M. H. Belz, E. A. Cornish, A. L. Stewart. (*Trans. of the Journal of the Inst. of Engineers, Australia, March, 1943, Vol. 15, No. 3, p. 53, 16 figs.*).

(1) *M. H. Belz* : All who are interested in manufacturing piece parts are also vitally interested in maintaining the quality of the product, whether this is decided by a direct measurement, or by observing the fraction defective. Frequency diagram. Histogram. Probability curve. Normal probability curve. Typical control chart. Control charts of mean and range. The yardstick also depends on the value of the percentage defective.

(2) *E. A. Cornish* : Showing how statistical methods can be used in framing a certain type of acceptance specification. Testing the conformity of a particular product with specification, two types of test are encountered. First, all articles produced can be tested, *e.g.*, in measuring the diameter of a shaft. Second, the product has to be destroyed, *e.g.*, in the final testing of ammunition, fuses, etc. An example of the second type is considered. Since this type of testing is both costly and destructive it must necessarily be done by sampling.

There is a marked tendency for the small single sample to misrepresent the batch. Chart showing the effect of chance in the selection of samples of 10. Curves show the relationship between probability of acceptance and rejection, and the proportion of defectives in the batch under test. The logical approach to a good specification involved three steps : (*i*) standard of quality, (*ii*) A design specification, (*iii*) An appropriate acceptance specification. Control chart.

(3) *A. L. Stewart* : An example was chosen to illustrate the practical application of quality control in the manufacture, on a quantity basis, of electro-mechanical apparatus and the component piece parts. Two changes were made in the inspection organisation and routine : (1) The system of " floating " inspection was organised so as to ensure regular visits to the machines, a fixed number of four piece parts being inspected at each visit.

(2) A system of process inspection record cards was introduced each card becoming, in effect, a complete case history of the relevant process. Analysis of milling operation. The control chart as a guide to action. Occurrence of trouble (afterwards put right) in milling a difficult casting. Summary of six months operating results with quality control during 1941-1942. Limits demanded and results obtained with time fuses. Suggested form for a control chart record.

SHOP MANAGEMENT.

Planning for Plant Maintenance, by C. D. Lightfoot. (*Mechanical World, July 30, 1943, Vol. 114, No. 2952, p. 130*).

A system of inspection and maintenance control designed to obviate breakdown. Plant record card. Card recording routine work for one day in a 28-day cycle. Job sheet for issuing daily.

Production Bonus, by W. F. Walker. (*Machine Shop Magazine, July, 1943, Vol. 4, No. 7, p. 44*).

Points that must be considered by the management are : (1) Can the management afford to pay the bonus on the present production and turnover ? (2) Is it advisable to pay bonus on the present turnover ? (3) Who are to qualify for the bonus ? (4) Will this bonus, if paid, lead to demands from other staff members ? (5) Will the introduction of a bonus mean extra labour for the accounting staff, and can it be easily understood by all concerned ? (6) Is there any known system of bonus payment suitable for this type of work ? Six tables : bonuses varied by alternative methods of stepping up production. Extra labour modifies bonus. Bonus and percentage on salaries. Labour value for each £1 of total works cost. It is not economical to pay bonus on percentage of labour per £1 of works cost.

How to Organise Suggestion Box Schemes. (*Production and Engineering Bulletin, June-July, 1943, Vol. 2, No. 8, p. 361, 8 figs.*).

The value of suggestion box schemes has been proved both in peace and in war. Subjects for suggestions. The suggestions committee. Joint production committees may help. Collecting the suggestions. The suggestion form. Help in submitting suggestions. Acknowledging. Recording. Reporting on suggestions. Putting the suggestion into operation.

The Management Review, (*June 1943, Vol. XXXII, No. 6, Index*).

The Management Review publishes a series of abstracts, some headings of which are given hereunder : Enterprise in Postwar America, p. 201. Controlling Office Production, p. 204. How to Use the Physically Handicapped, p. 208. Materials Control in Great Britain, p. 214. A Year of War Damage Insurance, p. 230.

SMALL TOOLS.

Getting the most out of die chasers. (*The Machinist, July 10, 1943, Vol. 87, No. 12, p. 83, 9 figs.*).

Buy chasers to do specific jobs. Grind them carefully using mechanical rests. Check throat and lip rake angles. Never overheat. In tempering, do not quench chasers in cold water.

Shear Tools for Interrupted Cutting (*Machinery, July 15, 1943, Vol. 63, No. 1605, p. 69, 5 figs.*).

Advantages of shear type tools. Design of shear type tools. Characterized by an unusually large so-called " negative back rake." Comparative performance of standard turning tool and shear type tool. Applications of shear type tools. Arrangement where shear type tools virtually eliminate vibration thus permitting higher cutting speeds. Interrupted cut using shear type carbide tools.

Developments in the (U.S.) Small Diamond Die Industry. (*Wire and Wire Prod., April, 1943, Vol. 18, No. 4, p. 230*).

A summary of the proceedings at a meeting of this committee on February 18, 1943. The committee represents the U.S. Government and industry. Requirements and production for 1943, examination of dies, organisation of a Government research laboratory.

(*Communicated by the British Non-Ferrous Metals Research Association*).

STANDARDISATION.

Standardisation as Applied to Industrial Electrical Instruments, by Lieut. Col. K. Edgcumbe. (*Journal, Inst. Elec. Engineers, July, 1943, Vol. 90, Part I, No. 31, p. 265, 9 figs.*).

The more important specifications of the British Standards Institution, dealing with industrial electrical measuring instruments (other than electricity meters). Their provisions compared with those of corresponding specifications issued in other countries. Suggestions are also made for their extension or amendment. Three groups: (1) Dealing with limits of performance, (2) Dealing with limits of dimensions or other attributes, intended—(2.1) to secure interchangeability, or (2.2) to cheapen manufacture by concentration upon a small variety of products. (3) Dealing with such matters as preferred terms, definitions, symbols, etc.

TECHNICAL EDUCATION.

She Trains Women Setters and Operators for Capstans. (*Production and Engineering Bulletin, June-July, 1943, Vol. 2, No. 8, p. 351, 1 fig.*).

Outstanding success of a demonstrator who received her higher grade instruction at a Government training centre.

WELDING.

Weld Finishing, by E. G. West. (*Sheet Metal Industries, July, 1943, Vol. 17, No. 195, p. 1242, 5 figs.*).

Weld finishing shall mean all operations following the deposition and solidification of weld metal. Both steels and the non-ferrous metals will be covered. The removal of slag is possibly the most important operation. Then it is usually desirable to obtain a smooth surface. Further, the properties of the weld metal can be improved. The first method of removing slag is to chip by hand or pneumatic hammer. Grinding may play some part. Brushing is done using either a hand or a revolving mechanical brush. The next method is that of washing, very often combined with some form of chemical treatment. Finally, there is the combination of perhaps chipping, brushing and washing, or chemical treatment, or special methods such as vibration. Light metal welds. The need for removing every particle of the flux residue. The only effective way of doing this is by washing in hot water. Testing by taking a sample of water from the third tank at intervals of say, half an hour and adding to that water a few drops of silver nitrate solution. If the washing is not effective the water immediately becomes cloudy. Cold or hot working. Steel welds are hammered to improve the structure. "Tough pitch" or high-conductivity oxygen-bearing copper must be hot-hammered. For deoxidised copper, *i.e.*, that which does not contain any free oxygen, hot-hammering is not necessary. Grinding is carried out by portable grinders or fixed machines. Table of grinding wheels recommended for use on welds.

It is essential to cut away the excess metal and not merely to fill up the uneven places. Inspection. The big cracks are obvious, but the small ones are difficult to detect. Proper finishing enables the inspector to detect any serious lack of reinforcement.

Welding Nickel, Monel and Inconel Clad Steels, by W. G. Theisinger. *Concluded from Welding, June, 1943.* (*July, 1943, Vol. XI, No. 8, p. 336*).

It is pointed out that clad steels are readily fabricated by welding provided a suitable welding electrode is used together with the appropriate technique.

A Combination Jig for Welding, by Henry Melich. (*Welding, July, 1943, Vol. XI, No. 8, p. 317, 17 figs.*).

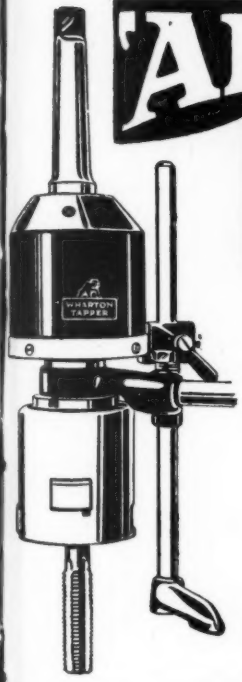
Advantages of jigs in welding : Provision of facilities for down-hand welding which results in better welds in less time. As it is hardly possible to design a really universal jig taking work of any shape and size a reasonable compromise must achieve the following essential requirements : (1) Easy to manipulate, (2) Of sturdy construction, (3) Adaptable by simple supplementary devices for work of any particular design and also for small quantity jobs, (4) It must not be too expensive and should facilitate working in a standing or in a sitting position. Such an almost universal jig is shown in 10 figures. Operation of jig demonstrated by 7 examples. The amount of time saved in setting up and in the actual welding by using the described combination jig depends not only on the skill of the individual operator, but also on the frequency of certain jobs, on the equipment available and on the methods employed prior to adoption of the jig. In some instances there will be up to 90 per cent. time saved in setting up, while in welding itself only little time is gained.

WELFARE, SAFETY, ACCIDENTS.

Fire Danger from Light Alloy Swarf, by Major Richard Twelvetrees. (*Machinery, July 22, 1943, Vol. 63, No. 1606, p. 89*).

How to reduce risk is here explained. Isolate the swarf. Do not permit any quantity to collect in one place in the shop: or to accumulate on the dump. Sprinklers are valuable. Effective extinguishers.

'ARCHER' Auto-Reverse TAPPERS



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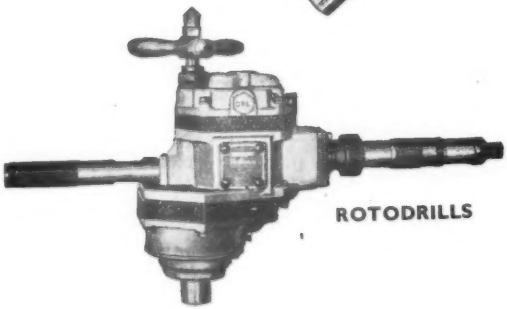

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